PB-215 219

WATER POLLUTION IN THE GRAND-CHARITON DRAINAGE BASINS

Public Health Service
Cincinnati, Ohio

June 1952

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PB 215 219

Water Pollution Series No. 22

For Clean Water – "One River, One Plan"

GRAND-CHARITON DRAINAGE BASINS

A COOPERATIVE STATE - FEDERAL REPORT ON WATER POLLUTION

JUNE 1952

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FEDERAL SECURITY AGENCY
Public Health Service

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FOREWORD

GRAND-CHARITON POLLUTION REPORT

The broad fertile valleys of the Grand and Chariton Basins are of great importance to the States of Iowa and Missouri. The agricultural products grown in this area are vital to the economy of the two States and furnish a substantial part of their food supplies. Also of considerable economic import is the bituminous coal production in the two Basins. It is the future possibilities of these two river Basins, however, that are even more important to the people of Iowa and Missouri.

The construction of major Basin reservoirs in the area will probably effect far reaching changes. Natural handicaps, including the high cost of producing a safe, potable, dependable water supply will be removed for many sections. The possibility of hydroelectric power and ample recreational facilities will further encourage the development of the area. On the whole, it would appear that both Iowa and Missouri have a great stake in these two river Basins.

Progress has been made in pollution abatement but much remains to be done. The employment of proper practices in strip mining operations can prevent future pollution from this source, but the recovery of the 140 miles of stream now known to be affected will be difficult and costly. It will require the combined efforts of local, State and Federal governments and the cooperation of the people living in these valleys. It should, however, serve as a lesson to us that pollution prevention, like the "ounce of prevention" is much less costly than corrective measures.

We sincerely hope that the citizens of the great States of Iowa and Missouri will be solidly behind the efforts of their State Health and Conservation Agencies in an all-out program to recover the lost ground, and protect to the maximum the future of the Grand and Chariton River Basins from damage resulting from pollution.

Walter L. Bierring, M.D.
Commissioner of Health of Iowa

James R. Amos, M.D.
Director, Division of Health of Missouri

A REPORT OF WATER POLLUTION

IN THE

GRAND-CHARITON DRAINAGE BASINS

Prepared by

IOWA DEPARTMENT OF HEALTH
Division of Public Health Engineering

MISSOURI DIVISION OF HEALTH
Bureau of Public Health Engineering

PUBLIC HEALTH SERVICE
Division of Water Pollution Control
Missouri Drainage Basin

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Federal Security Agency
Public Health Service
JUNE 1952

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal Agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters. Due regard must also be given to improvements necessary to conserve the waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural and other legitimate uses.

This report is produced under the coauthorship of the Missouri Division of Health, Iowa Department of Health, and the Public Health Service. It is based on data available as of June 1, 1952, on sources of pollution, treatment facilities employed, and stream conditions. The report also presents information concerning water resource use, pollution entering water resources and resulting damages, benefits which may result from pollution prevention and abatement, pollution prevention measures in effect and those which are needed.

Data and knowledge now available are sufficient to permit the immediate solution of many of the pollution problems within the Grand-Chariton River Basins without awaiting the results of additional surveys and studies.

A sincere effort has been made to present a fair picture of the water pollution problems in the Grand-Chariton River Basins and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive water pollution control program, will help in safeguarding the water resources of the Basins.

ACKNOWLEDGMENTS

Acknowledgment is made of the invaluable assistance rendered by the water pollution control agencies of the States of Missouri and Iowa. These agencies furnished the factual data in regard to sewage treatment works, stream conditions, and water uses in the Grand-Chariton River Basins.

Acknowledgment is also tendered to the Corps of Engineers, Department of the Army; the Bureau of the Census, Department of Commerce; the Fish and Wildlife Service and the Geological Survey, Department of the Interior, and Missouri State Conservation Commission. Much information was gleaned from reports of these agencies. Preliminary drafts of the report were reviewed by the Corps of Engineers, Omaha, Nebraska; Fish and Wildlife Service, Billings, Montana; the Federal Power Commission, Chicago, Illinois; the Department of Agriculture, Lincoln, Nebraska; the National Park Service, Omaha, Nebraska; Bureau of Reclamation, Denver, Colorado, and Department of Commerce, Denver, Colorado.

SUMMARY

The Grand-Chariton Basins contain about 11,000 square miles of north central Missouri and south central Iowa. The Grand River drains approximately 7,900 square miles and the Chariton, including the Little Chariton River, the remainder. The location of the Basins is indicated on Map No. 1. Topography is that of a plains area characterized by low, rolling hills interspersed with well defined valleys.

The economy of the region is supported largely through agriculture. Over 60 percent of the gainfully employed residents depend upon agriculture and its related industries for their livelihood. In addition to agricultural resources there are considerable quantities of bituminous coal underlying much of the Basin. Strip mining of coal is an important adjunct to the agricultural economy.

The population of the area is estimated at 313,000 people. Moberly, Missouri, population 12,833 (1950 census) is the largest city.

The surface water resources are used quite extensively as sources of public water supply, livestock watering, fish and wildlife propagation, recreation, and for removal and ultimate disposal of domestic and industrial wastes. Three miles of the Grand River above its mouth are considered navigable, however the only commercial craft using it in recent years have been sand barges. The poor quality of ground waters underlying the area has caused a preference for surface waters. Thirty-six towns of the area have public water supplies and 25 of them obtain water from streams and lakes.

Thirty-two municipalities and six separately sewered industries discharge their wastes at 49 different points to streams of the Grand and Chariton River systems. Twenty-five of the 32 municipalities have provided sewage treatment facilities. Four of the six industries have likewise provided some degree of waste treatment. It is estimated that the waste contributed to watercourses has a population equivalent of approximately 47,000. This includes both treated and untreated domestic and industrial wastes. Coal mine drainage has virtually destoyed aquatic life in 140 miles of stream reaches in the Missouri portion of the Chariton Basin. Similar pollution has not been reported in the Grand River Basin.

A resumé of waste treatment needs indicates recommendations for eight new municipal or institutional plants, addition to or enlargement of 14 municipal plants, and replacement of 5 municipal plants. New treatment works for industrial waste are needed at 5 industries. While pollutional effects from acid mine drainage have been recorded by the Missouri State Conservation Commission, this problem merits additional study in Iowa.

Damages to water resources by pollution are limited to local areas extending for relatively short distances below points of waste discharge. The substantial degree of pollution control now in existence in the Grand-Chariton Basins is the result of progressive programs by the State water pollution control agencies of Iowa and Missouri and

a concerned local citizenry. Most of the municipalities appear willing to provide the necessary improvements when satisfactory municipal financing programs can be arranged. An act recently passed by the Missouri State Legislature will enable Missouri cities to finance sewage treatment by revenue bonds to be retired by sewer service charges. This will allow effective and flexible financing of sewage treatment works. Legislation in Iowa appears adequate.

Data concerning sources of pollution in the Basins are generally complete. Recommendations for needed improvements may be revised when water uses or other conditions change as ascertained by the State water pollution control agencies.

The cost of providing the recommended new installations and improvements to existing plants is conservatively estimated at $1,627,000. This figure does not include the cost of constructing new sewer systems and sewage treatment works in municipalities where none now exist.

A listing of recommended projects is shown in table 1. The location of the streams and municipalities is shown on the General Reference Map.

Table 1. Grand-Chariton River Basins - Project list - Municipalities and industries needing improvements for abatement of pollution

Name	Estimated population served	Project needs*
Iowa		
Afton	600	Replacement (Secondary)
Creamery	600**	New plant or other control measures equivalent to secondary
Allerton	200	New plant (Secondary)
Centerville, N.E.Plant	5,000	Additions (Secondary)
Centerville, West Plant	2,200	Additions (Secondary)
Chariton, S.W.Plant	1,700	Replacement (Secondary)
Corydon	1,200	Replacement (Secondary)
Greenfield	1,600	Enlargement (Secondary)
Humeston	500	Enlargement (Secondary)
Lamoni	1,600	Replacement (Secondary)
Mount Ayr	1,300	Replacement (Secondary)
Missouri		
Brunswick	900	New plant (Primary)
Bucklin		
Poultry Packing Plant	725**	New plant or other control measures equivalent to secondary
Cameron	2,100	Enlargement (Secondary)
Chillicothe	6,100	New plant (Secondary)
Gallatin	750	New plant (Primary)

Table 1. Grand-Chariton River Basins - Project list - Municipalities and industries needing improvements for abatement of pollution (cont'd.)

Name	Estimated population served	Project needs*
Missouri		
Galt		
Cannery (inoperative for 2 years)	625**	New plant or other control measures equivalent to secondary
Grant City	170	New plant (Secondary)
Lathrop	700	Enlargement (Secondary)
Laclede		
Poultry Packing Plant	560**	New plant or other controls equivalent to secondary
Marceline, West Plant	900	Additions (Secondary)
Marceline, South Plant	900	Additions (Secondary)
Milan	1,000	Additions (Secondary)
Moberly, West Plant	2,750	Additions (Secondary)
Osgood		
Cannery (inoperative last 2 years)	300**	New plant or other controls equivalent to secondary
Princeton	800	New plant (Secondary)
Salisbury, North Plant	530	Additions (Secondary)
Salisbury, South Plant	530	Additions (Secondary)
Stanberry	1,200	New plant (Secondary)
Trenton	4,900	New plant (Secondary)
Unionville, North Plant	180	Additions (Secondary)
Unionville, South Plant	600	Additions (Secondary)

*As tentatively recommended by the State water pollution control agency having jurisdiction.

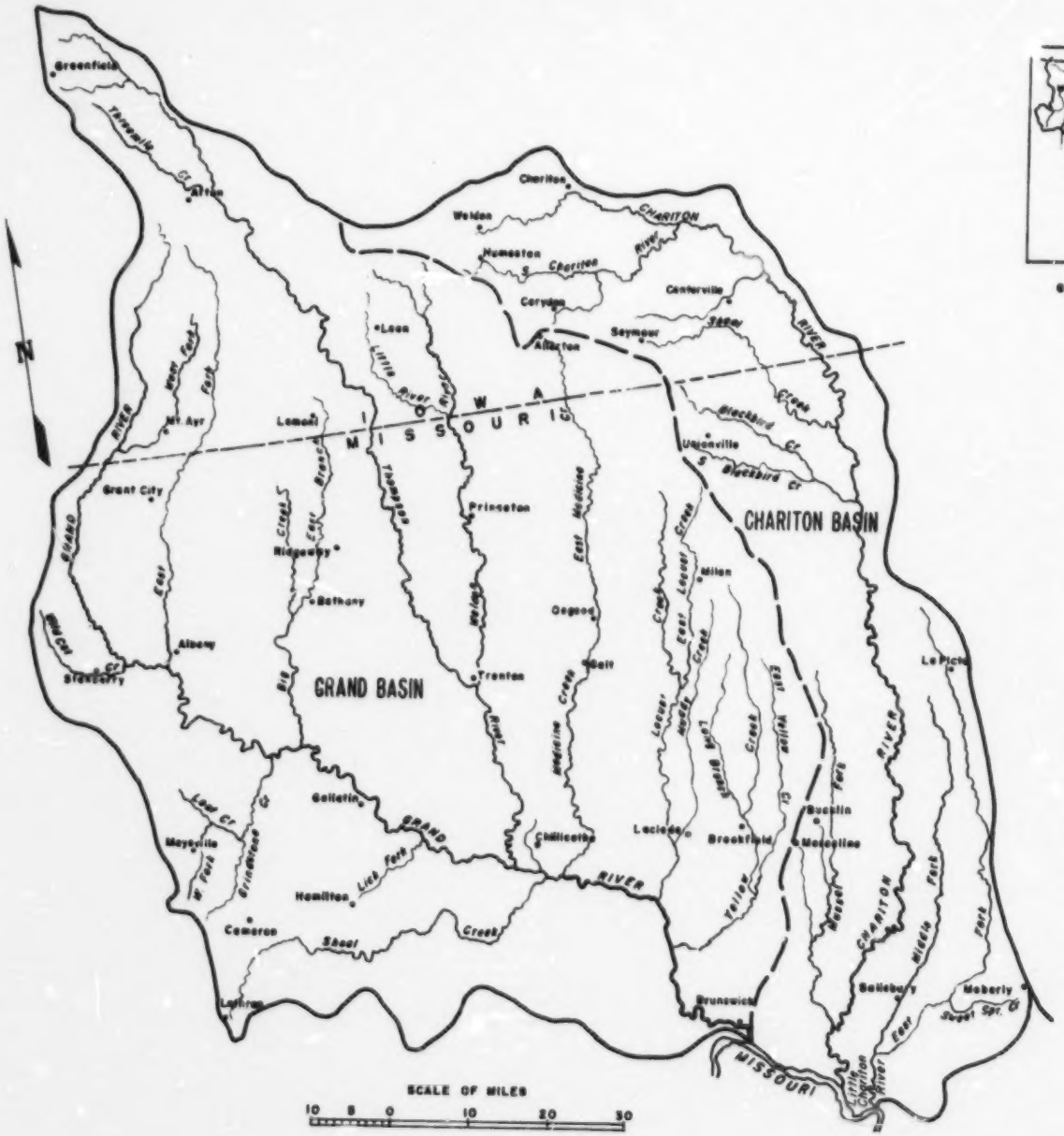
**Organic population equivalent of waste discharged by industry.

CONCLUSIONS

The following conclusions have been reached after examination of data pertaining to the physical and economic characteristics of the area, past effects of pollution, proposed water resource development program, legislative accomplishments, and the general attitude of the people within the region towards the abatement of pollution.

1. The economy of the Basins rests largely upon agricultural resources. All indications are that the Grand-Chariton Basins will remain rural in character.

2. The surface water resources of the Basins are used primarily for municipal water supply, livestock watering, and limited recreational purposes, of which game fishing is the most important. There are no hydroelectric power developments. Navigation is very


Greenfield
Tarkio
Clarinda
Creek
Braddyville
Shenandoah
Hamburg
Essex
Coin
Blanchard
Northboro
Clarinda
Corning
Villisca
Stanton
Red Oak
Griswold
Lewis
Atlantic
Anita
Audubon
Exira
Elk Horn
Harlan
Logan
Missouri Valley
Council Bluffs
Carson
Oakland
Neola
Crescent
Underwood
Minden
Honey Creek
Treynor
Hancock
Avoca
Pacific City
Shelby
Irwin
Manning
Arion
Dunlap
Persia
Woodbine
Modale
Missouri River
Little Sioux River
Soldier River
Boyer River
Little Boyer River
Mosquito Creek
Indian Creek
Keg Creek
Pigeon Creek
Walnut Creek
Silver Creek
Willow Creek
Mosquito Creek
Pony Creek
Weston
Bigelow
Mondamin
Pisgah
Magnolia
Little Sioux
Moorhead
Turin
Mapleton
Ute
Onawa
Whiting
Blencoe
Sloan
Salix
Smithland
Sergeant Bluff
Sioux City
Morningside
Leeds
Riverside
Correctionville
Cushing
Anthon
Oto
Holly Springs
Danbury
Lawton
Moville
Climbing Hill
Hornick
Concord
Pierson
Cherokee
Quimby
Aurelia
Alta
Linn Grove
Marathon
Peterson
Primghar
Sanborn
Ashton
Melvin
Sheldon
Hartley
Sibley
Ocheyedan
Gillett Grove
Spencer
Webb
Arnolds Park
Okoboji
Milford
Orleans
Superior
Terril
Wahpeton
Hartley
Spirit Lake
Lake Okoboji
Lake Minnewashta
Lake Pearl
Lake Shore
Lake Park
Milford
Emmetsburg
Graettinger
Ruthven
Everly
Fostoria
Gillett Grove
Royal
Estherville
Armstrong
Ringsted
Dolliver
Superior
Wallingford

limited and is employed only in the lower section of the Grand River. The flowing streams are used extensively for removal and ultimate disposal of waste products from urban communities and industries.

3. The development of flood control reservoirs in the Grand-Chariton Basins will expand most of the present water uses and thereby increase their value, particularly for public water supplies and recreation.

4. Wastes are discharged to the Grand and Chariton Basins at 49 different points. Sewage from approximately 53,000 people and organic industrial waste equivalent to 55,000 people are produced. Sewage and industrial waste treatment has been provided for about two-thirds of waste and the remainder (26,000 population equivalents) is discharged untreated. The strength of all the wastes, both treated and untreated, discharged to the Grand-Chariton River systems is estimated to have population equivalent of 47,000. Present treatment facilities reduce the strength of all the wastes produced by approximately 40 percent.

5. Treatment as recommended in this report would reduce pollution discharged to the streams of these Basins to about 10,000 population equivalents. Selfpurification properties of the stream appear capable of fully absorbing this residual organic waste without serious detriment to existing or expected future water uses.

6. Damage from pollution is largely to local interests and has been limited by an extensive sewage treatment program. Nuisance conditions caused by pollution do, however, exist below several municipalities and industries in the Basins. Acid mine waste is reported to have virtually eliminated aquatic life from approximately 140 miles of stream reaches within the Missouri portion of the Chariton Basin.

7. Benefits to be derived from extending the pollution control and abatement program are largely in the category of increased protection for domestic surface water supplies, recreational developments, livestock watering, and aesthetic values.

8. Twenty-five municipalities, or 78 percent of those having sewage collection systems, have some type of sewage treatment works. Approximately 75 percent of the urban* population of the Basins is served. This indicates that a generally favorable attitude towards sewage treatment is held by the people of the area.

9. Comprehensive stream pollution control legislation in the State of Missouri would tend to further stimulate stream pollution control. The recently enacted revenue bond law should provide considerable impetus to sewage treatment plant construction and maintenance in Missouri cities.

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*Towns of 300 or more people.

10. An analysis of the available information indicates a need for eight new municipal or institutional plants, five new industrial waste treatment works, addition to or enlargement of 14 municipal plants, and replacement of five municipal plants.

The conclusions presented are the result of a generalized study of available data. Subsequent investigations may indicate revisions.

RECOMMENDATIONS

The following recommendations are proposed to increase the effectiveness of the present pollution control program in the Grand-Chariton Basins. It is recommended that:

1. The legal authority of the water pollution control agency of the State of Missouri be broadened in scope to facilitate the development of a comprehensive stream pollution control program.

2. The State water pollution control agencies of Iowa and Missouri intensify their efforts to bring information concerning stream pollution to the attention of the public.

3. The need for adequate operation of existing sewage treatment works be recognized by State legislators and municipal authorities so that full benefit may be derived from these capital investments.

4. Periodic re-evaluation of stream conditions be made a part of a comprehensive control program of the State water pollution control agencies.

5. The municipalities now discharging raw sewage to streams of the Basins take immediate action toward treatment of their wastes. These are: Allerton, Iowa; Brunswick, Chillicothe*, Gallatin, Princeton, Stanberry*, and Trenton, Missouri.*

6. Obsolete plants located in the following cities be replaced: Afton/, Chariton/, Corydon, Lamoni/, and Mt. Ayr, Iowa.

7. Additional treatment units or the enlargement of existing units be provided at: Centerville, (northeast and west plants), Greenfield and Humeston, Iowa; Cameron*, Lathrop, Marceline (west and south plants), Milan, Salisbury* (north and south plants), Unionville (north and south plants), and Moberly (west plant), Missouri.

8. Treatment be provided for industrial wastes emanating from private outlets of industries in Afton, Iowa; Bucklin, Galt, Laclede and Osgood, Missouri.

9. Acid mine wastes in the Chariton River Basin be minimized through a program of improved mining practices.

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*Final plans for treatment have been made.
/Plans for improvements being prepared.

10. Missouri municipalities avail themselves of the financial advantages offered by the new municipal sewer revenue bond legislation recently enacted in the State of Missouri.

GENERAL DESCRIPTION

Historical Background

Early history of the Grand-Chariton Basins is rather obscure, however mention of the region was made in the writings of Robert Laurie and J. Whittle in 1794, and by Victor Collot in 1796. The Lewis and Clark Expedition made a cursory exploration of the area around the mouth of the Grand River in 1804.

The Grand River was originally called the Great River or LeGrande Rivere, from which its present name was evolved. The Chariton River is believed to have received its name from John Chariton, a French fur trader who settled near its mouth.

Hunters and trappers were the first white men to exploit the resources of the Basins. The Grand River later became an important transportation artery for the fur traders who wished to avoid the Indian tribes along the Missouri River to the west. Not until after 1842 when the Grand and Chariton valleys were ceded to the United States by the Sac and Fox Indians did settlement of the area begin. The Mormons in their emigration from Illinois camped here during the winter of 1846-1847; some remained to make their homes.

Prior to the construction of the railroads, steamboats regularly plied their way to Bedford, Missouri, about 60 miles above the mouth of the Grand River, and occasionally ascended as far as Utica, Missouri, but since 1870 little use has been made of the Grand River for navigation.

The agricultural resources of the Basins were recognized by the early settlers and have since constituted the principal source of livelihood for the populace.

Physical Description

The Grand-Chariton River Basins are characterized by low, rolling hills having a well defined drainage pattern. They contain approximately 11,000 square miles of area.

The Grand River rises in southern Iowa near the town of Afton. It flows southwesterly to the Missouri State Line then bends and continues in a southeasterly direction to its junction with the Missouri River. This junction occurs 251.8 miles above the mouth of the Missouri River. The Grand River is 217 miles long and drains an area of approximately 7,900 square miles. The average discharge of the Grand River near Sumner, Missouri, is 3,949 cubic feet per second during the years of record. About 6,880 square miles of its drainage basin lie above this gaging point. The average slope of the Grand River is 3.6 feet per mile, however its lower reach has a very shallow slope of only 0.5

feet per mile. Considerable portions of the Grand River and its tributaries have been subjected to bank improvements and channelization to protect adjacent land from periodic floods.

The Chariton River also rises in south central Iowa, near Weldon. It follows a southeasterly course to the Missouri-Iowa border, then flows in a generally southerly direction to its confluence with the Missouri River 24 miles downstream from the mouth of the Grand River. The Chariton River is 280 miles long and drains 2,960 square miles of area. The average discharge of the Chariton River near Keytesville, Missouri, is 1,092 cubic feet per second. About 1,950 square miles of the Chariton watershed lie above the gaging point. The average slope of the Chariton River is 1.3 feet per mile. Because of severe floods which frequently occur on the Chariton River, its channel has been subjected to bank improvement and straightening. As approximately 50 percent of the Chariton River has been channelized, its original characteristics have been altered considerably. Among the more important changes made in the Chariton River was the moving of its mouth several miles above its natural outlet to the Missouri River. As a result the Little Chariton River, once a principal tributary of the Chariton River, no longer flows into the Chariton but discharges directly to the Missouri through the old Chariton River channel. For the purposes of this report the Little Chariton River is considered a portion of the Chariton Basin. Table III, appendix B, presents the lengths of the streams and watershed area.

Precipitation is well distributed throughout the Basins and averages approximately 36 inches per year. The greatest amounts of rainfall occur during the months of May and June. The climate is further characterized by rather warm, humid summers and moderately cold winters. The mean annual temperature of the region is 51° F. The extreme temperatures of record are 114° F. and a -32° F. Table 5 of appendix B indicates the probable frequency of the low mean monthly discharges in the Grand and Chariton Rivers and their principal tributaries at several gaging stations.

Economic Development

Since the days of the early settlers agriculture has been the dominant industry in the area. Corn is the principal crop, however considerable quantities of oats, wheat, and hay are produced. Most of the grain and hay is fed to livestock. Dairying and poultry raising are important sources of income. Portions of the Basins also are well suited to growing tobacco. Approximately 60 percent of the gainfully employed persons depend on agriculture and related industries for a livelihood.

High grade bituminous coal is the most important mineral resource. Coal is strip mined readily and supplies markets in Iowa and Missouri. Sand and gravel deposits furnish construction material for local use.

The present population is estimated to be approximately 313,000 people, 200,000 of whom resided in the Grand River section and the remainder in the Chariton drainage area. A steady decline in population has occurred since 1920. The percentage of loss has been greatest in the rural areas. The numerous cities and towns serve chiefly as

Table 2. Grand-Chariton River Basins - Population of cities

Municipality*	Population--U.S.Census 1920	1930	1940	1950
Grand River Basin				
Iowa				
Afton	986	1,013	987	936
Allerton	954	784	782	761
Davis City	476	548	556	432
Diagonal	569	577	603	478
Garden Grove	660	558	558	417
Grand River	485	395	374	350
Greenfield	1,707	1,837	1,869	2,090
Kellerton	693	540	563	483
Lamoni	1,787	1,739	1,567	2,177
Leon	2,193	2,006	2,307	2,113
Lineville	707	531	520	482
Lorimor	678	577	614	505
Mt. Ayr	1,738	1,[illegible]	1,930	1,791
Murray	847	828	857	767
Pingley	391	358	390	333
Van Wert	463	369	383	318
Missouri				
Albany	2,016	1,858	2,010	1,840
Bethany	2,[illegible]80	2,209	2,682	2,705
Bagard	381	389	334	285
Bosworth	672	612	505	503
Brayner	1,018	933	975	955
Breckenridge	860	828	728	617
Brookfield	6,302	6,428	6,174	5,790
Browning	694	590	531	492
Brunswick	1,411	1,715	1,749	1,631
Calmesville	1,051	765	765	618
Cameron	3,248	3,507	3,615	3,969
Chillicothe	6,772	8,177	8,012	8,649
Chula	444	358	439	314
Cowgill	381	368	338	241
Eagleville	340	305	353	360
Gallatin	1,747	1,504	1,642	1,624
Galt	587	467	525	409
Gilman	618	535	555	450
Grant City	1,305	1,126	1,209	1,201
Hale	690	574	562	452
Hamilton	1,689	1,572	1,655	1,728
Jamesport	864	839	761	720
Kingston	371	395	394	338
Laredo	649	644	642	544
Laredo	728	578	544	486
Lathrop	1,100	940	1,049	888
Linneus	814	760	704	513
McFall	447	387	393	295
Marceline	3,760	3,595	3,208	3,150
Maysville	1,057	946	1,026	973
Meadville	616	540	509	446
Meadon	387	376	350	349
Mercer	442	364	430	377
Milan	2,395	2,002	2,016	1,896
New Hampton	519	449	412	375
Grand River Basin--Continued				
Missouri--Continued				
Osborn	354	381	358	237
Pattonsburg	1,068	1,009	1,017	883
Pelo	606	584	590	549
Princeton	1,576	1,509	1,584	1,5[illegible]
Purdin	355	341	303	295
Ravenwood	344	336	336	319
Ridgeway	812	676	675	560
Stanberry	1,864	2,089	1,893	1,641
Sumner	468	348	338	309
Trenton	6,951	6,992	7,046	6,210
Triplett	337	350	340	301
Winston	339	314	321	278
Chariton River Basin				
Iowa				
Centerville	8,486	8,147	8,413	7,606
Chariton	5,175	5,365	5,754	5,324
Cincinnati	1,301	911	899	703
Corydon	1,867	1,768	1,872	1,858
Exline	795	437	481	348
Humeston	1,214	924	903	750
Kyotic	2,796	1,953	1,884	1,247
Penn	602	399	322	248
Rathbun	630	899	352	289
Seymour	1,746	1,571	1,539	1,226
Missouri				
Armstrong	616	548	468	424
Atlanta	536	497	507	438
Bevier	1,868	1,289	1,105	838
Bucklin	863	932	842	783
Callao	542	468	398	370
Dalton	398	357	342	237
Ethel	389	399	317	226
Glenwood	890	333	315	258
Greencastle	487	376	342	287
Green City	905	783	697	673
Higbee	1,400	915	877	674
Huntsville	2,186	1,897	1,739	1,509
Keytesville	872	738	854	733
Kirksville	7,213	8,893	10,800	10,948
LaPlata	1,463	1,406	1,421	1,317
Marceline	3,760	3,595	3,206	3,172
Moberly	12,808	13,772	12,920	12,833
New Cambria	313	360	318	295
Novinger	1,743	846	793	734
Queen City	697	619	646	554
Salisbury	1,757	1,768	1,759	1,666
Unionville	1,765	1,811	2,052	2,042

*Includes those cities which have municipal water systems, sewage systems or 300 or more people.

marketing and distribution centers for the agricultural produce of the area. Moberly, Missouri, population 12,833, 1950 census, is the largest city.

The main lines of six railroad systems traverse the area and provide outlets in Kansas City, Chicago, St. Louis, and other important industrial and population centers. Numerous Federal, State, and County highways connect the cities and towns, and have materially aided farm-to-market transportation.

Per capita income in the area indicates that the economic status is equal to or slightly above the national average. The general development, which includes agricultural and other industries, is progressing at a rate slightly less than that of the national average.

Table 2 shows the population of cities and towns of the area.

USES OF WATER RESOURCES

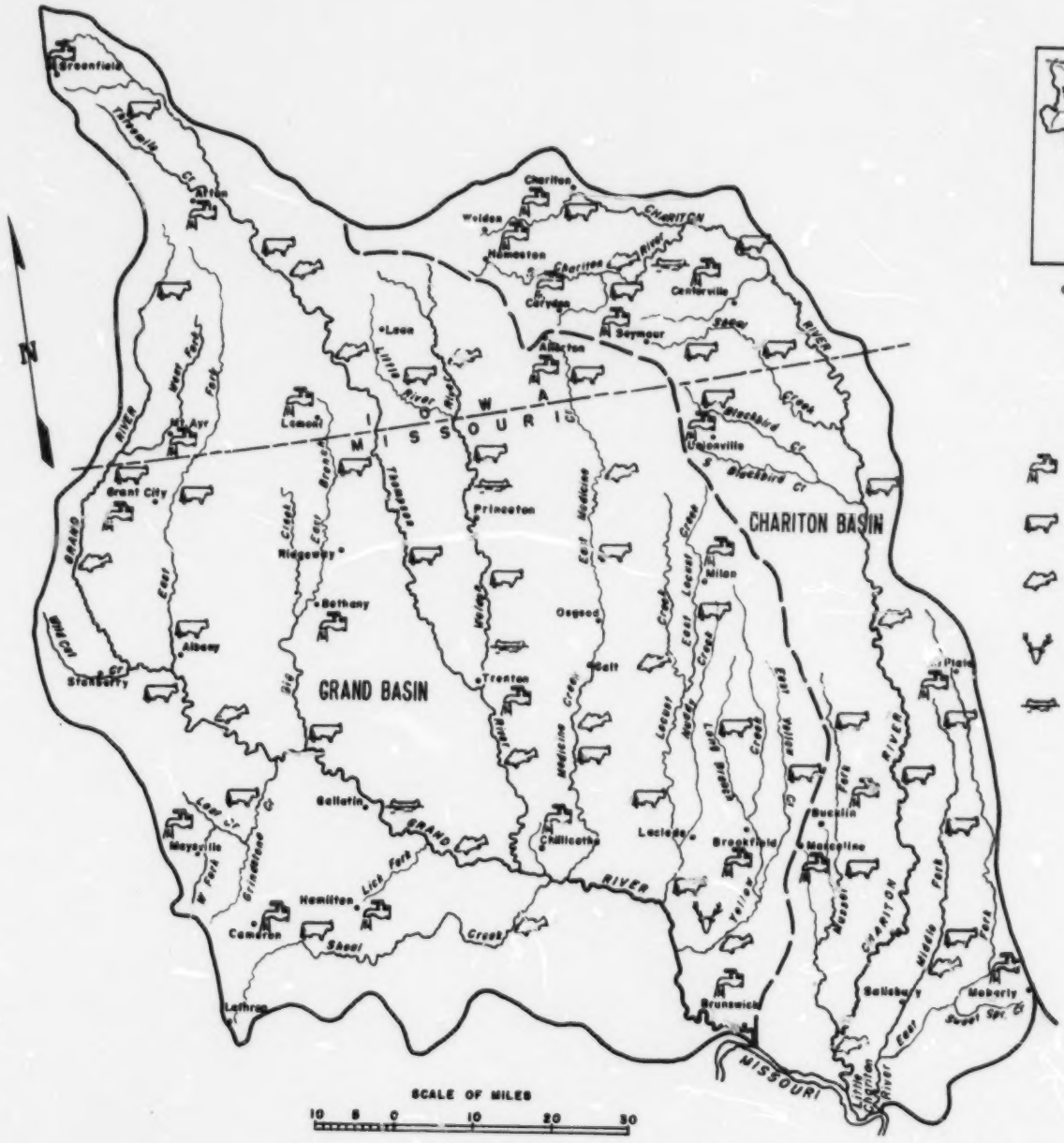
The surface water resources of the Grand-Chariton River Basins supply the public systems of 25 municipalities. Surface waters are also used extensively for livestock watering, for fish life and recreation for people of the region.

The high mineral content of ground waters has encouraged the development of surface sources for public supplies. Twenty-one municipal supplies are taken from impounding reservoirs, 4 from flowing streams, and 11 from wells.

During the past two decades numerous stock watering and soil conservation ponds have been constructed throughout the Basin. Many of these serve several purposes, including recreation and the propagation of fish life. The streams do not offer many opportunities for recreation or lend themselves to the development of valuable fisheries because of their usually turbid condition and their susceptiveness to floods.

Prior to 1900 the streams were used extensively as sources of water power for local grist mills, however the mills have long since been abandoned. No hydroelectric power is being produced within the confines of the Basins. Navigation is now practically nonexistent on the streams, although at one time the Grand River formed an important artery of transportation. Use of the streams for removal and ultimate disposal of municipal and industrial wastes is important.

The State governments of both Iowa and Missouri have encouraged greater development of the water resources of the area. The Corps of Engineers, Department of the Army, has proposed the construction of reservoirs, levees, and channel straightening for the primary purpose of controlling floods. The reservoirs would also serve several other very important water uses. It is expected that the completion of this program will lead to increased numbers of surface water supplies, greater recreational opportunities, and better pollution control.


CHARITON BASIN
GRAND BASIN
MISSOURI
Princeton
Trenton
Chillicothe
Brookfield
Laclede
Milan
Bethany
Albany
Gallatin
Hamilton
Cameron
Lathrop
Brunswick
Salisbury
Moberly
Macon
Keytesville
Carrollton
Norborne
Grant City
Ridgeway
Stanberry
Maysville
Osgood
Meadville
Marceline
Bucklin
Linneus
Laclede
Yellow Creek
Blackbird Cr
Shoal Creek
Big Creek
Medicine Creek
Locust Creek
East Locust Creek
East Yellow Creek
Middle Fork
Little Shoal Cr
Shoal Spr Cr
Little Muddy Cr
Muddy Cr
Big Muddy Cr
Lost Cr
Grindstone
Big Creek
Weldon
Chariton
Centerville
Seymour
Allerton
Leon
Little River
Shoal River
Chariton River
Thompson River
Weldon River
West Fork
East Fork
Big Muddy
Big Creek
Locust Creek
Medicine Creek
Shoal Creek
Yellow Creek
Middle Fork
Little Shoal Cr
Shoal Spr Cr
Lost Cr
Grindstone
Big Creek
Little Muddy Cr
Muddy Cr
Big Muddy Cr
Blackbird Cr
Shoal Creek
Big Creek
Medicine Creek
Locust Creek
East Locust Creek
East

Important water uses in the Basins are depicted on map No. 2. A listing of the municipal water supplies is shown in tables I and II of appendix A.

POLLUTION CONTRIBUTED TO WATER RESOURCES

The waterways of the Grand-Chariton River Basins receive municipal sewage and industrial waste at 49 different locations. The strength of the waste discharged to the streams is estimated to have an organic population equivalent of 47,000. Of this amount 26,000 population equivalents originating in Allerton, Iowa; Gallatin, Princeton, Trenton, Chillicothe, Brunswick, and Stanberry, Missouri; are discharged without treatment. Trenton, Missouri, discharging waste having population equivalent of 9,650 into the Thompson River, is the largest single source of pollution.

Seventy miles of the East Fork of the Chariton River and 70 miles of the Chariton River are polluted by inorganic acid mine waste. Sections of the streams mentioned are in a state of chronic pollution and aquatic life has been practically eliminated in these areas.*

Approximately 73 percent of the sewage and industrial waste reaching the streams originates in the Missouri section of the Basins and the remainder in Iowa. Installed treatment reduces the over-all strength of the polluting materials by about 40 percent. The waste prior to treatment has an estimated population equivalent of 78,000. Approximately 53,000 people contribute sewage to existing systems and industry adds an additional 25,000 population equivalents. About 21,000 population equivalents of industrial waste enter municipal sewers and the remainder through privately owned sewers. Tables 3 and 4 list the municipal and industrial sources of pollution respectively, and maps 3 and 4 depict the location of the sources.

DAMAGES TO WATER RESOURCES FROM POLLUTION

The State water pollution control agencies have indicated that livestock water supplies and game fishing have suffered most from pollution. While damage to public water supplies has not been reported, it is apparent that four cities obtaining water supplies from flowing streams are subjected to upstream pollution, principally untreated sewage.

Specific instances of pollution damages are found below Greenfield, Iowa, on the Thompson River, and Afton, Iowa, on Twelve Mile Creek; Allerton, Iowa, on the East Branch of the Medicine Creek; Mount Ayr, Iowa, on the Middle Fork of the Grand River, and Lamoni, Iowa, on Seven Mile Creek. The streams mentioned are generally unsatisfactory for livestock watering, the principal water use. Interstate pollution below Lamoni, Iowa, is probable, but has not posed a major problem.

*Missouri Conservation Report, "Acid Mine Drainage in Missouri Streams."

Table 3. Grand-Chariton River Basins - Basic data on sources of municipal pollution

Name and location of municipality	Sewered population	Estimated untreated waste population equivalent	Treatment provided	Adequacy of treatment: Sup'y	Adequacy of treatment: Oper.	Population equivalent discharged (estimate)	Project needs	Current status of community action
Grand River								
West Fork								
Wild Cat Creek								
Stanberry, Mo.	1,200	1,800	None	-	-	1,800	NP	Final plans approved
Middle Fork								
Mt. Ayr, Iowa	1,300	1,300	Secondary	Una.	Una.	800	R	Inactive
Branch			(4 plants)					
Grant City, Mo.	170	170	Primary	Una.	Una.	119	NP	Final plans approved
East Fork								
Albany, Mo.	1,400	1,485	Secondary	Sat.	Sat.	70	None	
Grindstone Creek								
Lost Creek								
West Fork Lost Creek								
Mayesville, Mo.	500	500	Secondary	Sat.	Sat.	50	None	
Big Creek								
East Fork Big Creek								
Seven Mile Creek								
Lamoni, Iowa	1,600	2,400	Secondary	Una.	Una.	1,800	R	Plans under preparation
Branch								
Ridgeway, Mo.	400	400	Secondary	Sat.	Una.	120	Improved oper.	
Bethany, Mo.	1,325	1,325	Secondary	Sat.	Sat.	470	None	
Gallatin, Mo.	750	790	None	-	-	790	NP	Inactive
Lick Fork								
Hamilton, Mo.	940	940	Secondary	Sat.	Sat.	169	None	
Thompson River								
Greenfield, Iowa	1,600	2,300	Secondary	Una.	Sat.	1,000	R	Inactive
Twelve Mile Creek								
Afton, Iowa	600	600	Septic tank	Una.	Una.	400	R	Final plans approved
Weldon River								
Little River								
Leon, Iowa	1,800	2,400	Secondary	Sat.	Sat.	600	None	
Princeton, Mo.	800	800	None	-	-	800	NP	Inactive
Trenton, Mo.	4,900	9,650	None	-	-	9,650	NP	Final plans approved
Tributary								
Chillicothe, Mo.	6,100	7,350	None	-	-	7,350	NP	Final plans approved
Shoal Creek								
Lathrop, Mo.	700	950	Secondary	Una.	Sat.	130	R	Inactive
Branch								
Cameron, Mo.	2,100	3,500	Secondary	Una.	Sat.	350	R	Final plans approved, bonds voted
Medicine Creek								
East Branch								
Allerton, Iowa	200	3,200	None	-	-	3,200	NP	Plans under preparation
Locust Creek								
East Locust Creek								
Milan, Mo. (East plant)	300	2,620	Septic tank	Una.	Sat.	1,969	A)	Plans under preparation
Milan, Mo. (South plant)	700	700	Primary	Una.	Sat.	490	)	
Yellow Creek								
West Yellow Creek								
Brookfield, Mo.	4,200	4,380	Secondary	Sat.	Sat.	438	None	
East Yellow Creek								
Branch								
Marcelline, Mo. (W.plant)	900	900	Primary	Una.	Sat.	540	A	Plans under preparation
Brunswick, Mo.	900	1,650	None	-	-	1,650	NP	Inactive
Chariton River								
Chariton, Iowa (S.W.plant)	1,700	2,000	Secondary	Una.	Una.	800	R	Plans under preparation
South Chariton River								
Humeston, Iowa	500	500	Secondary	Una.	Sat.	150	R	Inactive
Branch								
Corydon, Iowa	1,200	1,200	Primary	Una.	Una.	1,000	R	Inactive
			(3 plants)					
Tributary								
Seymour, Iowa (East plant)	630	630	Secondary	Sat.	Sat.	100	None	
Centerville, Iowa(S.E.plant)	5,000	5,500	Secondary	Una.	Una.	1,500	A	Inactive
Centerville, Iowa(West plant)	2,200	2,200	Secondary	Una.	Una.	600	A	Inactive
Shoal Creek								
Seymour, Iowa (S.W. plant)	75	75	Secondary	Sat.	Sat.	25	None	
Blackbird Creek								
North Blackbird Creek								
Branch								
Unionville, Mo.(N.plant)	180	180	Secondary	Una.	Una.	54	A	Inactive
South Blackbird Creek								
Branch								
Unionville, Mo.(S.plant)	600	1,400	Secondary	Una.	Una.	700	A	Inactive
Puzzle Creek								
Salisbury, Mo. (N.plant)	530	530	Primary	Una.	Sat.	371	A	Final plans approved
Mussel Fork								
Clark Branch								
Locust Branch								
Marcelline, Mo. (S. plant)	900	900	Primary	Una.	Sat.	540	A	Plans under preparation
Little Chariton River								
East Fork								
Long Branch								
La Plata, Mo.	980	980	Secondary	Sat.	Sat.	294	None	
Sweet Spring Creek								
Troublesome Creek								
Moberly, Mo.(W. plant)	2,750	4,804	Primary	Una.	Sat.	3,130	A	Plans under preparation
Middle Fork								
Branch								
Salisbury, Mo.(S. plant)	530	530	Primary	Una.	Sat.	370	A	Final plans approved

Note: NP - New Plant
R - Replacement
A - Additions
E - Enlargements

Sat. - Satisfactory
Una. - Unsatisfactory

Table 4. Grand-Chariton River Basins - Basic data on sources of industrial pollution

Name and location	Type of industry	Type of waste produced	Treatment or other pollution control measures		Population equivalent discharged to watercourse	Pollution abatement measures needed	Project status
			Degree	Adequacy			
Grand River							
Thompson River							
Three Mile Creek							
Afton Creamery Afton, Iowa	Food & kindred products	Organic	Minor	Inadequate	600	New plant or other controls	Inactive
Grand River							
Medicine Creek							
Food Cannery (Osgood, Mo.)	"	Organic	None	Inadequate	300	New plant or other controls	Inactive
Food Cannery (Galt, Mo.)	"	Organic	None	Inadequate	625	New plant or other controls	Inactive
Locust Creek							
Muddy Creek							
Poultry Packing Laclede, Mo.	"	Organic	Minor	Inadequate	560	New plant or other controls	Inactive
Chariton River							
Mussel Fork Creek							
Van Dosen Creek							
Poultry Packing Plant Bucklin, Mo.	"	Organic	Minor	Inadequate	725	New plant or other controls	Inactive
East Fork, Little Chariton R.							
Sweet Spring Creek							
Troublesome Creek							
Meat Packing Plant Moberly, Mo.	"	Organic	Secondary	Adequate		None	

In Missouri, pollution contributed from Gallatin, Lathrop, Cameron, and Chillicothe has seriously damaged the waters of the Grand River for fish propagation and recreational activity. Damages also occur to livestock watering, game fishing, and other recreational activities below Ridgeway, Grant City, Marceline, Milan, Stanberry, Princeton and Trenton, Missouri.

Waters of the Chariton River Basin are impaired as sources of livestock water and for fishing below Chariton, Humeston, Corydon, and Centerville, Iowa, and below Salisbury, Moberly, and Unionville, Missouri.

According to the 1951 survey of the damage effected by acid mine waste in Missouri streams, the Missouri Conservation Commission reports 70 miles of the East Fork of the Chariton and 70 miles of Middle Fork of the Chariton River as receiving such wastes. Aquatic life has been virtually eliminated in the affected areas. No mine wastes have been reported from the Iowa portion of the Chariton Basin or in the streams of the Grand River Basin.

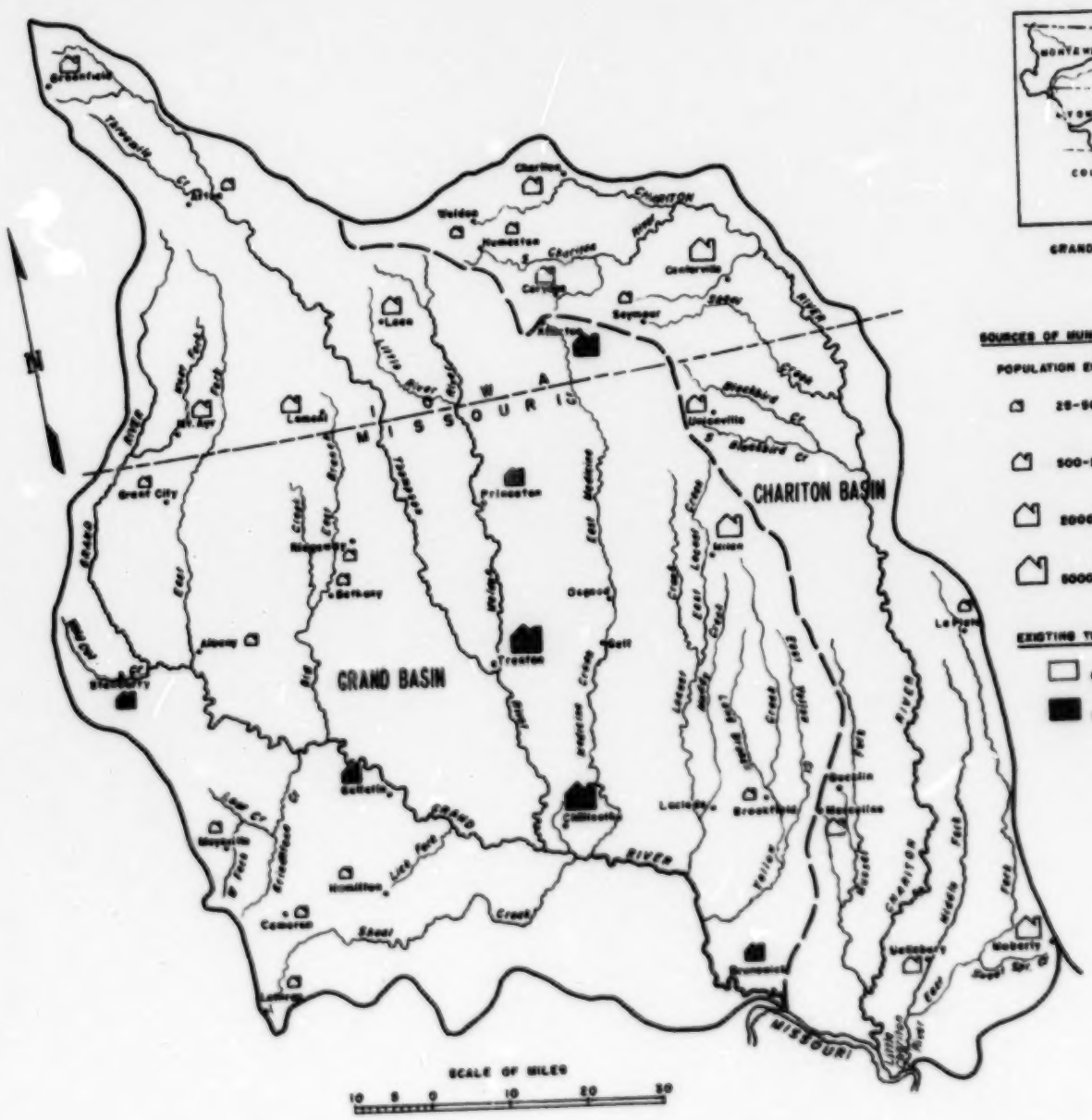
BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

The principal benefits due to pollution abatement in the Basins have accrued to landowners and livestock raisers whose interests in the streams have been protected. Pollution abatement has also protected public water supplies taken from surface sources. Water supplies undoubtedly would be in a less favorable condition had not abatement measures been installed at upstream sources of pollution.

Benefits from pollution abatement will increase as the Water Resources Development Plan for the Grand-Chariton Basins becomes an operating program. The Iowa State Planning Board in its second report concludes that: "Almost any type of stream improvement must be predicated on the abatement of existing pollution. In future planning of projects concerning the use of the streams as water supply or for scenic, recreational, or wildlife conservation, the findings of the pollutional surveys should be given thorough consideration. On most streams the pollutional load would be seriously detrimental to such projects and on some streams the very purpose of such development would be defeated unless the pollutional load was relieved." It is highly probable that if the development plan is carried to completion there will be an increased number of public water supplies taken from surface sources and that recreational facilities within the Basins will be greatly expanded. Both uses will be enhanced if pollution in the waterways can be adequately controlled.

One of the most important but less tangible aspects of pollution control is the aesthetic value of a clean stream. The psychological effect of a clean environment upon man is difficult to measure by monetary standards. It exists and is of a prime importance. It is axiomatic that when a man's surroundings are pleasant and healthful he tends towards a longer and more productive life.

The waterways of the Grand-Chariton Basins have a moderate value as fishing streams. Existing measures of sewage treatment undoubtedly



GRAND-CHARITON RIVER BASINS

LOCATION MAP

SOURCES OF MUNICIPAL POLLUTION

POPULATION EQUIVALENT (B.O.D.) OF WASTES DISCHARGED TO STREAM

- 25-500
- 500-2000
- 2000-5000
- 5000 AND OVER

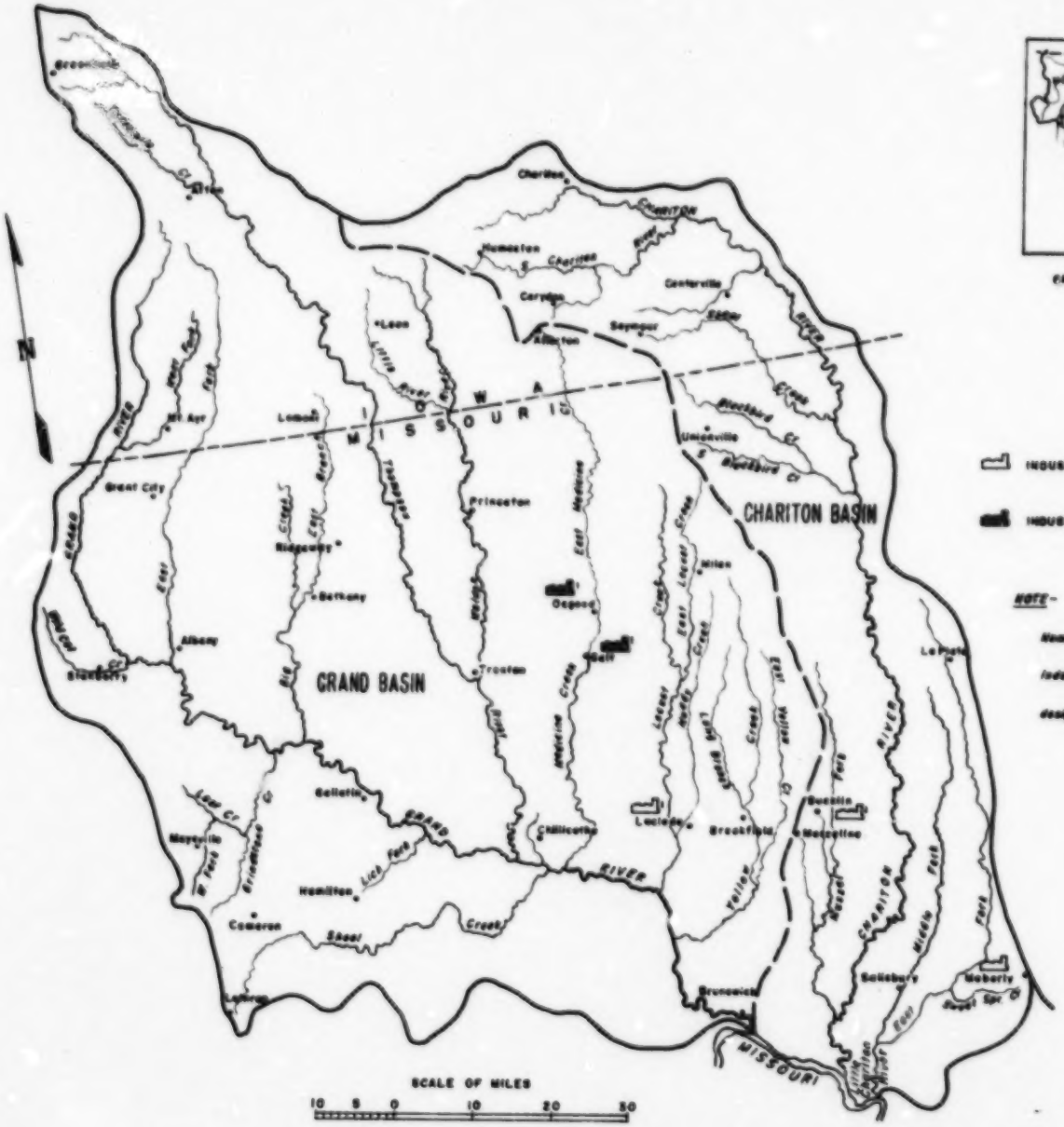
EXISTING TREATMENT FACILITIES

- MUNICIPALITIES WITH TREATMENT FACILITIES
- MUNICIPALITIES WITH NO TREATMENT FACILITIES

GRAND-CHARITON BASINS

SOURCES OF MUNICIPAL POLLUTION AND EXISTING TREATMENT FACILITIES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 3



GRAND-CHARITON RIVER BASINS

LOCATION MAP

INDUSTRIES WITH TREATMENT FACILITIES

INDUSTRIES WITH NO TREATMENT FACILITIES

NOTE-

Numbers appearing by symbols indicate total number of industrial sources of pollution in the area in the category designated

GRAND-CHARITON BASINS

SOURCES OF INDUSTRIAL POLLUTION AND EXISTING TREATMENT FACILITIES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 4

have been a factor in the increased quantity and variety of the fish population. Financial returns realized from the sale of fishing permits and sporting goods are indirect benefits resulting from stream pollution abatement.

The Fish and Wildlife Service, U. S. Department of Interior, maintains a wildlife refuge at Sumner, Missouri. Hunting is permitted during season. The full value of such a refuge depends on the continued control of pollution entering the waterways feeding the lakes and marshes.

POLLUTION PREVENTION MEASURES IN EFFECT

Twenty-five Missouri and Iowa communities within the confines of the Grand-Chariton River Basins operate sewage treatment facilities. Many of the plants effect a very high degree of treatment while others, due to obsolescence and poor operation, are of little value in reducing pollution. The fact that a rather high degree of pollution control exists is due to the activities of the water pollution control agencies of the States of Iowa and Missouri, and to local citizens who are unwilling to allow the destruction of their streams by unabated pollution.

The State Department of Health of Iowa is that State's responsible agency for the control of stream pollution. The statutes of Iowa are generally adequate to provide the authority necessary to prevent and abate pollution. The Iowa Department of Health has been diligent in its efforts to bring about the abatement of pollution and, as the record indicates, has been quite successful.

The Missouri Division of Health has the major resposibility for stream pollution control in Missouri. The Division of Health has accomplished much without the benefit of adequate legislation. Missouri statutes limit the Division of Health's authority to control pollution to only those stream reaches that would affect the public health through public water supplies and nuisances.

The State health agencies exercise control over the construction of municipal and industrial treatment works by requiring that plans and specifications for sewage treatment structures be submitted for approval. This requirement has protected the interests of the public and has resulted in municipal waste treatment works adequate to meet the needs. Iowa statutes require that a potential polluter must obtain a permit prior to the discharge of any industrial or domestic waste to any stream. This system has made it possible for the Iowa State pollution control agency to keep informed of new sources and types of wastes and to require adequate treatment prior to their discharge into the watercourses.

A large measure of present control can be attributed to the public health educational programs instituted by the State agencies. The effects of pollution have been discussed with many local groups. Operators of sewage treatment works have been kept informed concerning new methods of treatment and improvements in older methods It is the practice in both Iowa and Missouri to conduct frequent district conferences

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of sewage treatment plant operators in a concerted effort to raise the general level of operation. The State pollution control agencies plan regular visits to sewage treatment works at which time the plants are inspected and reports of their condition prepared for submission to municipal officials. The plant inspections are supplemented by occasional stream investigations in order to determine effects of contributed pollution on the biochemical and biological characteristics of the streams.

Many treatment works have served the communities over a 20 to 30 year period. Continuous growth of the municipalities, however, has overtaxed the capacity of some of them to a point where their efficiency has been seriously reduced.

The protection of watersheds of impounding reservoirs whose primary purpose is to supply municipalities with a source of water is considered of paramount importance by the State water pollution control agencies. The general lack of recreational facilities has made the impoundments very attractive as recreational areas. The State health departments in an effort to protect public water supplies have found it necessary to issue strict regulations regarding sanitation on the watersheds of impoundments. Boating and fishing are usually allowed, but swimming is generally prohibited. Construction of cabins and attending sanitary facilities is carefully controlled in order to prevent undue pollution of impoundments. It is expected that the pressure on present recreational facilities will be relieved when the reservoirs now proposed primarily for flood control in the Basins have been constructed. Tables 5 and 6 list the number, method of treatment and adequacy of pollution abatement facilities now in operation. Table 7 indicates the number of municipal and industrial treatment plants constructed 1946-1950.

Table 5. Grand-Chariton River Basins - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	7	12	8,580
Secondary	18	24	29,730
No treatment	7	-	14,850

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

Table 6. Grand-Chariton River Basins - Adequacy of existing treatment facilities - Municipal and industrial

Existing treatment facilities	Adequacy with relation to:				
	Capacity			Operation	
	Number	Satisf.	Unsatisf.	Satisf.	Unsatisf.
Municipal*	36	10	26	20	16
Industrial**	4	1	3	1	3

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

**Industries having separate outlets discharging wastes directly to watercourse.

Table 7. Grand-Chariton River Basin - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0		0	-
1947	1	750	0	-
1948	0		0	-
1949	1	1,500	0	-
1950	0		0	-

POLLUTION PREVENTION MEASURES NEEDED

Present water uses and increased or additional uses possible with improved water quality together with protection of water rights and property values largely determine the pollution prevention measures needed. The objective of water pollution control programs is to preserve and reclaim water to best serve these interests. Treatment requirements like other aspects of water resources development are generally influenced by economic consideration. In addition, the intangible aspects of moral obligation, aesthetic values and nuisance conditions exert a powerful and positive influence on the justification of waste treatment facilities.

Water quality objectives have been fairly well developed for such water uses as domestic and industrial water supply, recreation, bathing, and support of fish and other aquatic life. Objectives are less well defined for other uses.

Among the more important objectives of a water pollution control program is protection of water quality in streams used as sources of public water supplies. The quality of raw water is an important factor in the design of water treatment facilities and their operation and maintenance. The factor of safety which can be incorporated in the best water treatment facilities is, however, inversely proportional to the specific concentrations of bacteria and toxic elements in water used as source of supply. Therefore, public health and waterworks officials generally measure water quality in terms of its bacteriological, physical, and chemical characteristics. While definite standards of raw water quality have not been adopted, the Manual of Recommended Water Sanitation Practice, Public Health Service Bulletin No. 296, 1946, recommends the following practices: Underground waters not subject to any possible contamination and meeting in all respects the requirements of the Public Health Service Drinking Water Standards as shown by satisfactory, regular and frequent sanitary inspections and laboratory tests require no treatment. Underground or surface waters which are subject to a low degree of contamination not averaging more than 50 M.P.N. per 100 ml. in any month and meeting the requirements of the Public Health Service Drinking Water Standards in all other respects should be treated by simple chlorination or its equivalent. Waters which require filtration treatment for turbidity and color removal, waters of high or variable chlorine demand, and waters polluted by sewage to such an extent as to be inadmissible in the prior groups but containing numbers of coliform bacteria averaging not more than 5,000 M.P.N. per 100 ml. in any one month and exceeding this number in not more then 20 percent of the samples examined in any one month should be provided complete rapid sand filtration treatment or its equivalent, together with continuous postchlorination. Waters which meet the requirements of the previous statement with respect to limiting monthly average coliform numbers but showing numbers of coliform exceeding 5,000 M.P.N. per 100 ml. in more than 20 percent of the samples examined during any one month and not exceeding 20,000 per 100 ml. in more than 5 percent of the samples examined during any month should be provided auxiliary treatment in addition to complete filtration treatment and postchlorination. Auxiliary treatment as used here is presedimentation or prechlorination or their equivalents either separately or combined as may be necessary. Long time storage for periods of 30 days or

more represents a permanent and reliable safeguard which in many cases would provide something more than an effective substitute for one or both of the two other methods indicated. Waters which do not meet the requirements cited are considered unsuitable for use as sources of water supply unless they can be brought into conformance with the requirements by means of prolonged preliminary storage or some other measure of equal permanence and reliability as heavy prechlorination and preliminary coagulation and sedimentation.

In addition to the recommended bacterial requirements, waters for public supply should not contain toxic taste producing or otherwise harmful substances or organisms not readily and completely removed by the water treatment processes cited since water should be free of excessive amounts of acid, microscopic organisms, and organic matters causing any interference with the normal operation and efficiency of the water treatment processes. Waste treatment thus often determines the acceptability of a water for domestic or industrial supply.

Standards adopted by the Public Health Service for Drinking and Culinary Water Supplied by Common Carriers in Inter-State Commerce prescribe limiting maximum concentrations of certain chemical substances inimical to public health, including the following:

Substance	Maximum concentration in parts per million
Lead	0.10
Fluoride	1.50
Arsenic	0.05
Selenium	0.05
Hexavalent chromium	0.05

These standards have received official approval by the American Water Works Association and general acceptance by official health agencies and water works authorities and are widely used as one of the guides for administration of water pollution control programs.

Also of importance are those substances which cause problems of taste and odors. Of particular concern are phenolic and related compounds, minute concentrations of which cause repugnant taste and odor in water supplies. Pollution control programs are aimed at practical elimination of these substances in waters serving as a source of domestic supply.

Quality requirements for industrial water supply vary widely, depending upon the type and nature of industry under consideration. Of general concern are organic and biological constituents, toxic substances, and properties of corrosion, encrustation, and slime formation. Waste control measures materially contribute to improvement of these qualities.

It is generally agreed by fishery specialists that a minimum of 5.0 parts per million of dissolved oxygen is necessary in those streams of the Grand-Chariton Basins affording a suitable fishery habitat, for

support of a balanced aquatic life. Because of limited dilution water during critical periods of low flow, secondary treatment, or removal of not less than 75 percent of the Biochemical Oxygen Demand* (B.O.D.), is required for most sources of pollution in the Basins. Where the quantity of waste is large, as in principal towns where industry is concentrated, a degree of removal substantially in excess of 75 percent may be required to maintain desirable oxygen levels. Removal approaching 90 percent is possible with secondary treatment facilities properly designed and well operated.

Contamination of bathing waters by sewage, especially that of recent origin, is objectionable. Also water for recreational usage should be free from floating solids, sludge banks odors and discoloration. Objectives for the bacteriological quality of bathing waters endorsed as tentative guides by Iowa and Missouri water pollution control agencies are as follows:

For bathing or swimming water, monthly arithmetical average 'most probable number' of coliform organisms should not exceed 1,000 per 100 ml. during any month of the recreational season; nor exceed this number in more than 20 percent of the samples examined during any such month; nor exceed 2,400 per 100 ml. on any day. For nonbathing or nonswimming waters, the monthly arithmetical average 'most probable number' of coliform organisms should not exceed 5,000 per 100 ml. in any month of the recreational season, nor should exceed this number in more than 20 percent of the samples examined during any such month. Other indices of quality, as fecal streptococci, are receiving increasing attention, and sanitary surveys must continue to play the major role in pollution control programs as related to bathing waters.

The protection of water rights must also be considered in determining pollution prevention measures needed. The doctrine of riparian rights widely applied in States east of the 98th meridian holds that "all persons owning land abutting on a natural stream have a right to demand that the water shall pass their lands undefiled in quality and undiminished in quantity."** The interpretations of the doctrine vary but in general a "reasonable" approach is applied in which stream uses are permitted which do not substantially lessen its quantity or impair its quality. West of the 98th meridian the doctrine of appropriated water rights is usually accepted, although in many areas State water laws incorporate a portion of both doctrines. Where the doctrine of appropriated water rights prevails, consumptive use of water is permitted but no license is thus given to return water to the stream in a defiled condition. The riparian doctrine governs in the States of Iowa and Missouri.

Waste treatment measures are usually tailored to the needs of a community following the engineering evaluation of local sanitary problems. Municipal treatment plants are usually of two general types, one of which removes settleable material from the water under quiescent

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*Biochemical Oxygen Demand is the quantity of oxygen utilized by microorganisms under aerobic conditions while feeding on and stabilizing organic materials.

**Merriman and Wiggins, American Civil Engineers Handbook, page 1750--Legal and Economic Features of Water Rights, 5th edition.

flow conditions and the other removes polluting material by biological means. Within these categories numerous combinations or adaptions thereof can be used to meet variant conditions of waste from a community and requirements of the receiving stream. Industrial treatment processes vary widely, often within the same general type of industry. Changes in processes, by-products recovery, salvage, waste prevention, and comparable practices are often very effective measures of controlling industrial pollution and should be employed in every instance. Control of industrial waste may present an entirely different problem than that incurred in municipal wastes, since the wastes may contain toxic or otherwise objectionable substances not amenable to either sedimentation or biological treatment. However, the objective of the control program remains the same--protection of waters by reduction of objectionable substances to within tolerance levels compatible with water uses. The water pollution control programs in the Grand-Chariton Basins are based on these premises.

While sewage and waste treatment processes cannot be controlled precisely, they can be regulated between rather well established limits. The effective removal of solids from domestic wastes by sedimentation is termed primary treatment and is generally considered to reduce B.O.D. from 25 to 40 percent. The removal of Biochemical Oxygen Demand by biological methods is termed secondary treatment. A plant incorporating effective primary and secondary treatment is generally considered capable of removing from 75 to 85 percent of the organic polluting material. Greater reduction, sometimes referred to as tertiary treatment, can be obtained by repetitive passages of wastes through the treatment processes or by increasing the number of combinations of treatment processes. Sewage and waste treatment methods thus defined apply only to organic materials that can be decomposed by biological action or those that may be removed by sedimentation. Inorganic waste such as most acids, alkalies and metallic ions must be controlled by recovery, neutralization, storage, evaporation, dilution or other specialized processes. In general, the water pollution control agencies of Iowa and Missouri recognize the following concepts:

(1) Toxic substances including metallic ions, phenol compounds, oils, and acids must be excluded from streams. Such substances are inimical to aquatic life and if present in sufficient concentrations are hazardous to human life and to livestock.

(2) Removal of settleable and floating solids to prevent sludge banks, floating materials and nuisance conditions should be required as the minimum acceptable treatment. Property values, recreation, fishing, stock watering, and other water uses are thus provided a measure of protection.

(3) The degree required beyond effective primary treatment is influenced by downstream water uses and by the amount of dilution water available during periods of low flow. Biological removal of dissolved organic materials and bacteria must be provided where necessary to: (a) maintain dissolved oxygen at levels necessary for balanced aquatic life; (b) maintain desirable water quality for domestic, industrial or recreational uses; and (c) prevent nuisance or other health hazards.

(5) For industrial wastes similar in nature to municipal wastes, treatment should be based on the same premises as that recommended for municipalities. For industrial wastes not similar to municipal wastes, treatment should be provided as necessary to prevent substantial deterioration of water quality in the receiving stream.

Future water pollution control programs in the Grand-Chariton Basins will be largely a matter of extending present work with emphasis on:

(1) The enactment of comprehensive pollution control legislation in Missouri;

(2) The provision of plants where none now exist, and the improvement of existing plants which are now inadequate;

(3) Dissemination of information concerning the effects of pollution on public health, fishing, and other water uses;

(4) Better operation and improved maintenance of existing sewage treatment plants;

(5) Surveillance of stream conditions to supplement sewage treatment plant inspections so that the need for improved treatment can be foreseen well in advance of actual necessity, thus enabling planning and construction to be carried forward with a minimum of delay.

(6) Minimizing the adverse effects of mine drainage by effecting a program of improved strip mine operations.

Stream pollution control legislation in the State of Iowa has been in effect many years and was recently amended to permit broader coverage and has been found to be adequate in most respects. A detailed review of the Iowa legislation is found in appendix C of this report.

Stream pollution control legislation in Missouri is limited in scope and pertains only to the effects that pollution might have on public health, via public water supplies or nuisances. A rather high degree of stream pollution control has been effected by the responsible State agencies of the State of Missouri without the benefit of a comprehensive stream pollution law. Comprehensive stream pollution control legislation in the State of Missouri would do much to bring together common interests in stream pollution control, would generally expedite stream pollution control actions, and would establish a single agency charged with the responsibility for a comprehensive stream pollution control program. The psychological value of such legislation is of considerable importance and would greatly aid any informational program embarked upon by the responsible State agency. A review of the Missouri legislation is presented in appendix C.

Recent legislation in the State of Missouri covering the financing of municipal sewage systems greatly increases the flexibility of municipal financing in that State. It provides that revenue bonds can be issued for the purpose of financing construction, operation, and maintenance of municipal sewage treatment works. Municipal sewage works

financing laws of the State of Iowa have been somewhat more liberal than those in Missouri prior to 1951.

A number of flood control dams have been proposed for the Grand-Chariton Basins. Appendix B, table IV, lists these tentative sites. The inclusion of storage capacity in reservoirs for water needed to augment low flows would benefit the stream pollution control program. Controlled release of the water from these reservoirs would augment low stream flows and increase the amount of water available for diluting sewage treatment plant effluents. The availability of greater sustained flows should not be interpreted to mean that dilution should supplant treatment. It would, however, supplement it.

Surveys of many of the sources of pollution in the Grand-Chariton Basins have been made by the State water pollution control agencies and reports, containing findings of the investigations together with recommendations for correcting or improving conditions, have been provided municipal and industrial officials and other interested parties. State reports are available for public inspection. The State water pollution control agencies have further cooperated with representatives of numerous industries and municipalities through conferences regarding specific problems of pollution, and have worked closely with the engineers officially employed by municipalities and industries to study pollution problems. These activities were inaugurated several years ago as a part of a continuing program. Numerous engineering studies have been made and, while some were made sometime ago, they generally substantiate treatment needs as indicated in this report. Table 8 summarizes the sewage and waste treatment needs of the Grand-Chariton Basins. Table 9 indicates the status of projects. Maps 5 and 6 depict the needs discussed in this section.

A synopsis of recommended sewage treatment practices to be maintained at municipalities, institutions, and industries to prevent and abate pollution in the Grand-Chariton River Basins is presented as follows:

Stanberry, Missouri

Stanberry discharges sewage equivalent in strength to that produced by 1,800 people, of which 600 population equivalents are produced by industry located in Stanberry. Sewage and industrial waste is discharged untreated to Wild Cat Creek, thence to the Grand River. The pollution has affected the use of the stream below Stanberry for livestock watering, game fishing, and other recreational uses. Detailed plans and specifications for a sewage treatment plant employing primary and secondary treatment have been approved by the Missouri Division of Health. No action has yet been taken by the municipal authorities to construct these facilities.

Mt. Ayr, Iowa

Approximately 1,300 people contribute sewage to the four sewage treatment plants at Mt. Ayr. The existing treatment works consist of septic tanks and improvised rock filters constructed more than 20

years ago, and through obsolescence and overloading they are now incapable of providing treatment sufficient to prevent pollution of the waterways. The Iowa State Department of Health recommends that the plants be replaced by secondary treatment works.

Grant City, Missouri

Approximately 170 people are connected to the sewer system of Grant City. Treatment is provided by an Imhoff tank considered inadequate by the Missouri Division of Health, who reports that stream usage below Grant City has been impaired for livestock watering, fishing, and other recreational uses. Plans and specifications for a new treatment plant employing secondary treatment have been approved by the Division of Health. No action has been taken by the municipality to construct these facilities.

Lamoni, Iowa

The sewage system of Lamoni serves approximately 1,600 people. Sewage and industrial wastes are treated in an Imhoff tank and trickling filter, which the Iowa State Department of Health reports as being grossly overloaded. The Department of Health recommends that the present plant be replaced by a modern treatment plant sufficient in size to treat the wastes. Industrial wastes from the Lamoni packing plant and a large creamery are also discharged into the municipal system. As a result the treatment plant has become overloaded and nuisance conditions exist for several miles downstream from the present sewage treatment plant. Plans for a replacement plant were prepared several years ago, but must now be revised to greater capacity to provide treatment for the packing house wastes. A sewer service charge was adopted by Lamoni in 1950 to assist in financing the needed improvements.

Gallatin, Missouri

Sewage from 750 people residing in the town of Gallatin is discharged without treatment to the Grand River. The Division of Health reports that the pollution has damaged fishing and recreational use of the stream to some degree, and during periods of low flow has impaired the use of the stream for livestock watering. The sewage from Gallatin also induces an added hazard to the Chillicothe water supply taken from the Grand River below Gallatin. A sewage treatment plant employing primary treatment should be installed at Gallatin in the near future. No action on this recommendation has been taken by the city officials.

Greenfield, Iowa

The City of Greenfield provides sewage service, including treatment, to about 1,600 people. Treatment facilities consist of an Imhoff tank and trickling filter which in recent years has become greatly overloaded. The Iowa State Department of Health recommends that the present plant be enlarged sufficiently to provide adequate treatment. A considerable portion of the present municipal waste originating in Greenfield comes from a creamery and locker plants.

Afton, Iowa

Approximately 600 people are served by the municipal sewage system of Afton. A septic tank is used for treatment purposes. It is reported that the treatment plant is grossly overloaded and operation has not been satisfactory. The Iowa State Department of Health has recommended that the present plant be replaced by a modern installation capable of producing the required treatment. Plans for a new treatment plant have been approved by the State Department of Health.

The creamery at Afton discharges its waste after minor treatment into Twelve Mile Creek. The Iowa Department of Health has recommended a new waste treatment works capable of adequately treating the wastes.

Princeton, Missouri

The City of Princeton discharges untreated sewage to the Weldon River. The Missouri Division of Health reports that pollution from Princeton has damaged the stream reach below the city for stock watering, game fishing, and recreational uses, and recommends that a new sewage treatment works employing secondary treatment be installed at Princeton. No positive action has yet been taken by municipal officials towards construction of a sewage treatment plant. The need for treatment of sewage at Princeton is influenced by the Trenton public water supply which is derived from the Thompson River, approximately 30 miles below the City of Princeton.

Trenton, Missouri

The sewage of Trenton, equivalent in strength to that produced by approximately 9,650 people, is discharged through numerous outfalls without treatment into the Thompson River, East Muddy Creek, and Weldon River. About half of the pollution originates from industries located in Trenton. Water use below Trenton has been seriously curtailed due to pollution. The Missouri Division of Health has recommended that a sewage plant employing secondary treatment be provided at Trenton. The need for sewage treatment is influenced by the fact that Chillicothe derives its water supply from the Grand River approximately 30 miles below Trenton. Sewage treatment works should be constructed at Trenton in the very near future. Plans for a new plant to discharge into East Muddy Creek have been approved. Bond issues have been voted down by the citizens of Trenton; however, recent passage of the revenue bond act in Missouri may provide an acceptable alternate plan of sewage works financing.

Chillicothe, Missouri

Approximately 6,100 people are served by the municipal sewage system of Chillicothe. In addition to the domestic sewage, waste with a population equivalent of approximately 1,200 is contributed to the municipal sewers from industry. The entire waste load is discharged untreated into the Grand River. The Missouri Division of Health reports that water use in the stream below Chillicothe has been impaired for livestock watering, fishing and other recreational uses, and has

recommended that a sewage treatment plant employing secondary treatment be constructed to reduce the pollution. Plans for such a treatment works have been approved by the Division of Health and construction should proceed as soon as possible.

Lathrop, Missouri

Approximately 700 people in the Town of Lathrop, Missouri, are served by the sewage system which includes secondary treatment. The capacity of the plant is no longer sufficient to provide the degree of treatment necessary as evidenced by deterioration of the stream receiving effluent from the treatment plant. The Missouri Division of Health reports that fishing in Shoal Creek is impaired and that use of waters of the creek for livestock watering has been damaged and has recommended that the plant facilities be enlarged. Action by the town authorities on this recommendation has not been fully completed.

Cameron, Missouri

The municipal sewage system of Cameron serves approximately 2,100 people, a poultry packing plant and a dairy. The industries contribute approximately 1,400 population equivalents of waste. Treatment is provided and the waste finally discharged to a branch of Shoal Creek, thence to Shoal Creek and the Grand River. The sewage treatment facilities have been overtaxed and can no longer be depended upon to produce an effluent compatible with the best uses of the waters of the receiving stream. It is reported that fishing and stock watering have been damaged in the streams below Cameron. The Missouri Division of Health has recommended that the present treatment works be modified and enlarged to provide effective secondary treatment. Plans and specifications for this improvement have been approved by the Division of Health and on the second attempt the necessary bond issue was voted. Construction is expected to begin soon.

Osgood, Missouri

A small cannery located at Osgood discharges wastes during its seasonal operation having a population equivalent of 300. The cannery operates during the months of August and September and empties its wastes to a branch of Medicine Creek. The cannery has been inoperative for at least two years. If the industry is reactivated, secondary treatment should be provided.

Galt, Missouri

A canning plant at Galt, Missouri, is contributing wastes to Medicine Creek with a population equivalent of 625. No treatment is provided. The cannery has been inoperative for at least two years. If the industry is reactivated, secondary treatment should be provided.

Allerton, Iowa

Sewage from about 200 people and industrial wastes from a creamery and locker plant organically equivalent to that which would be expected

from 3,000 additional people is contributed to Medicine Creek without treatment. The Iowa State Department of Health reports that the creek below Allerton is grossly polluted and that nuisance conditions exist. The Department of Health has recommended that sewage treatment be provided at Allerton. Preliminary plans for the construction of a sewage treatment works providing secondary treatment have been submitted to the Iowa State Department of Health. Construction has been held in abeyance because of difficulties encountered in financing the project.

Milan, Missouri

The municipal sewage system of Milan serves approximately 1,000 people, in addition to industrial wastes organically equivalent to 2,300. The waste is treated in two separate plants locally known as the East Plant and the South Plant. Both plants are overloaded and treatment is insufficient to produce an effluent compatible with the best uses of the stream. In fact, nuisance conditions prevail for a considerable distance below the discharge lines of the municipal sewage treatment works. The Division of Health has recommended that the primary treatment facilities of the South Plant be improved and that secondary treatment be provided, and a pumping station be installed to eliminate the East Plant. A consulting engineer has been employed to prepare detailed plans for this improvement.

Laclede, Missouri

The Town of Laclede, Missouri, does not have a community sewage system. However, a poultry packing plant contributes a substantial quantity of industrial waste to the Muddy Creek Branch of Locust Creek. The waste is estimated to have a population equivalent of 560. The packing plant has provided a septic tank in which a small portion of the solid material in the waste is settled out, and the remainder discharged to the stream. It is reported that the treatment plant is grossly overloaded and that nuisance conditions exist in the stream below the sewage outfall line. The use of the stream for fishing and stock watering has been damaged. The Missouri Division of Health recommends that the present treatment works be considerably expanded to provide the equivalent of secondary treatment.

Marceline, Missouri

The sewage system of Marceline serves approximately 1,800 people. About one-half of the waste is treated in the west plant, the effluent from which is discharged into a branch of Yellow Creek, thence to the Grand River. The remainder of the waste is discharged to the south plant, the effluent from which eventually reaches the Chariton River. Water uses below the discharges of both plants have been seriously impaired. The Missouri Division of Health has recommended that secondary facilities be provided at each plant. Correction of the pollution in Yellow Creek is important to the continued existence of the wildlife refuge located along Yellow Creek near Sumner, Missouri. The city has hired a consulting engineer to prepare an engineering report. An early vote on a bond issue is anticipated.

Brunswick, Missouri

The municipal sewer system serves approximately 900 people in the City of Brunswick. In addition, industries in Brunswick contribute wastes with a population equivalent of 750 people. The sewage is discharged into the Grand River without treatment. The Missouri Division of Health has recommended that a sewage treatment plant employing primary treatment be provided at Brunswick. No action towards complying with this recommendation has been indicated by the city officials.

Ridgeway, Missouri

The Town of Ridgeway has provided sewage treatment facilities but, because operation has been neglected the branch of Seven Mile Creek, into which the effluent of the plant is discharged, is at times badly polluted. The Missouri Division of Health recommends that operation of the existing plant be improved.

Chariton, Iowa

The sewage system of Chariton serves approximately 5,000 people. Treatment is provided in four separate plants. However, only one of these discharges its effluent to the Chariton River. The other three plants are in the Des Moines River Basin. The present treatment plants are reported to be grossly overloaded. All of the plants have been in operation more than 20 years. The State Department of Health reports that the Chariton River is subjected to pollution extreme enough to impair its use for stock watering and fishing and recommends that the present treatment plants be replaced by modern facilities incorporating a degree of treatment sufficient to control the polluting effects of the Chariton sewage.

Humeston, Iowa

Approximately 500 people in Humeston are provided with sewage service including treatment. The treatment plant is reported to be inadequate to control pollution in Wolf Creek. The State Department of Health recommends the existing treatment plant be enlarged.

Corydon, Iowa

The sewage originating in Corydon is treated in three separate plants, all of which are obsolete and incapable of producing an effluent of satisfactory quality. The State Department of Health reports that nuisance conditions exist in the waterways below the plant outlets, thus seriously interfering with use of the stream for stock watering and for fishing. The Department of Health recommends that the existing plants be replaced by modern treatment works capable of producing the necessary degree of treatment.

Centerville, Iowa

About 7,200 people are served by the municipal sewer system of Centerville. Treatment for the sewage is provided in two plants, both of which need additional treatment units. The Iowa Department

of Health recommends that necessary treatment units be added to the plants in order to properly treat the sewage.

Unionville, Missouri

Sewage and industrial wastes with a population equivalent of about 1,600 are treated in two sewage treatment plants. Approximately 800 population equivalents of waste are produced by industry located in Unionville. The treatment plants consist of Imhoff tanks and trickling filters and are reported to be overloaded. The effluent from the plants contains sufficient polluting material to impair the waters into which they are discharged. The Missouri Division of Health recommends that secondary treatment including final settling be provided at both plants and that the quality of operation be improved.

Bucklin, Missouri

The Town of Bucklin does not have a community sewage system. However, the poultry packing plant is contributing waste to Van Dosen Creek. These wastes have a population equivalent of 725. Treatment measures have been instituted at the poultry packing plant, however they are considered inadequate to meet the need. The Missouri Division of Health recommends that a new waste treatment plant equivalent to secondary treatment be provided. No action has been taken to comply with this recommendation.

Moberly, Missouri

That portion of Moberly sewage system which discharges its wastes into the Chariton River Basin serves 2,750 people. Industrial waste with a population equivalent of about 2,000 is added by Moberly's industries. The municipal wastes are provided primary treatment then discharged to Troublesome Creek. The existing plant is grossly overloaded and nuisance conditions have been observed in the stream below its outlet. The State Division of Health recommends that the present plant be modified to provide secondary treatment and final settling. City officials have conferred with consulting engineers on the problem and indicate that corrective measures will be taken in the near future.

Salisbury, Missouri

Sewage treatment facilities provided for the wastes of the Town of Salisbury are inadequate to provide the necessary treatment. Nuisance conditions have been observed in the stream into which the plants discharge their effluent. Stock watering and game fishing have been seriously impaired. The Division of Health has recommended that effective secondary treatment be provided. While final plans for this improvement have been approved, no action has been taken to construct the facilities.

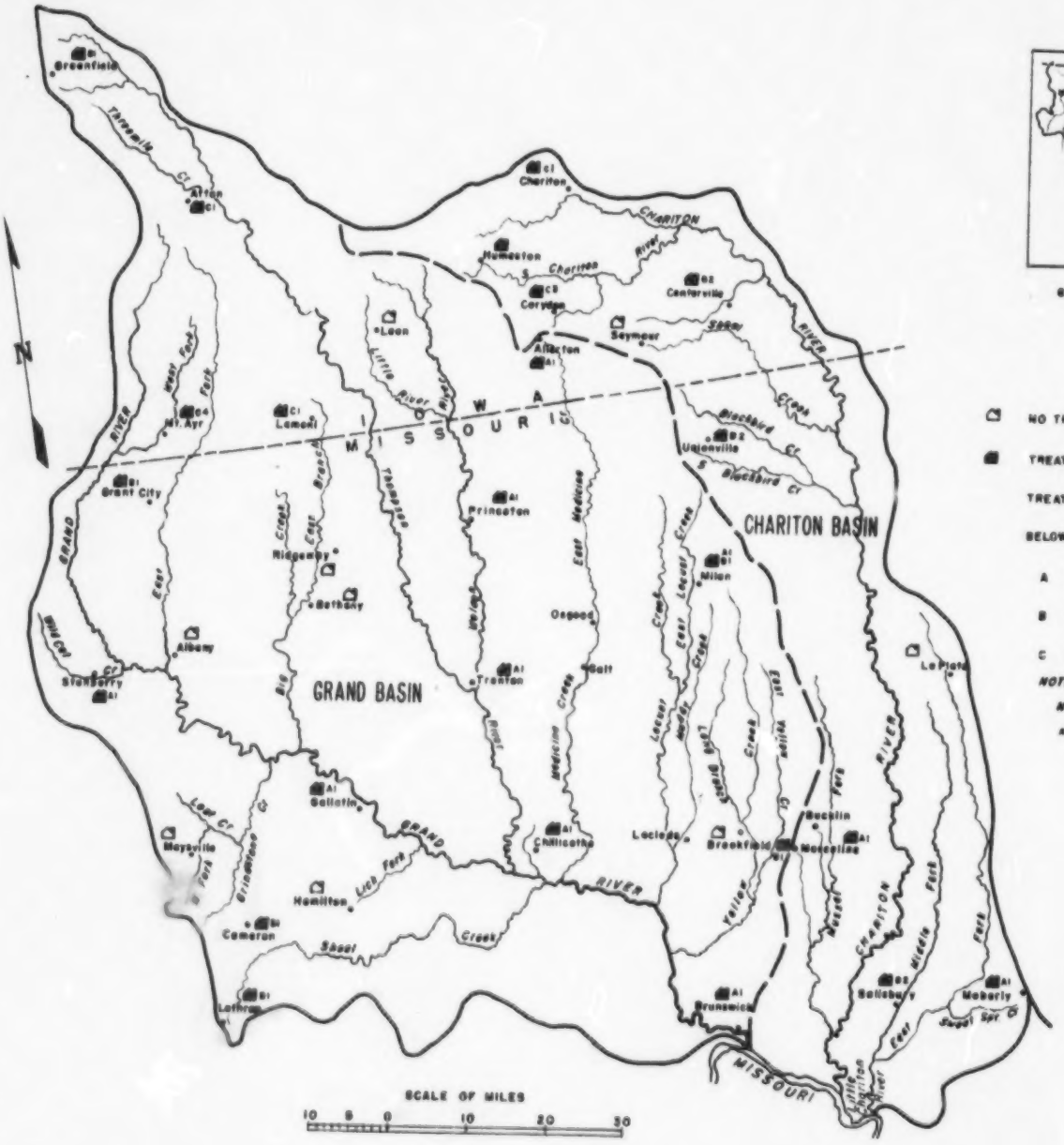
Table 8. Grand-Chariton River Basins - Needs for municipal and industrial waste treatment plants

	Municipal		Industrial
Needs	Number	Population served by facilities	Number
New plant	8	15,020	5
Enlargement or additions to existing plant	14	19,490	0
Replace existing plants*	10	6,400	0
No project required	10	12,250	1

*Seven plants in two municipalities to be replaced by single units if possible.

Table 9. Grand-Chariton River Basins - Current status of municipal and industrial action on pollution abatement needs

Status of project	Number of municipalities	Number of industries
Inactive	12	5
Abatement ordered	0	0
Final plans approved	8	0
Construction awaiting financing	0	0
Under construction	0	0
Plans under preparation	7	0



GRAND-CHARITON RIVER BASINS

LOCATION MAP

NO TREATMENT NEEDS

TREATMENT NEEDED

TREATMENT NEEDS INDICATED BY LETTERS APPEARING BELOW 'TREATMENT NEEDED' SYMBOLS, AS FOLLOWS:

A NEW PLANT

B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT

C REPLACE EXISTING PLANT

NOTE–

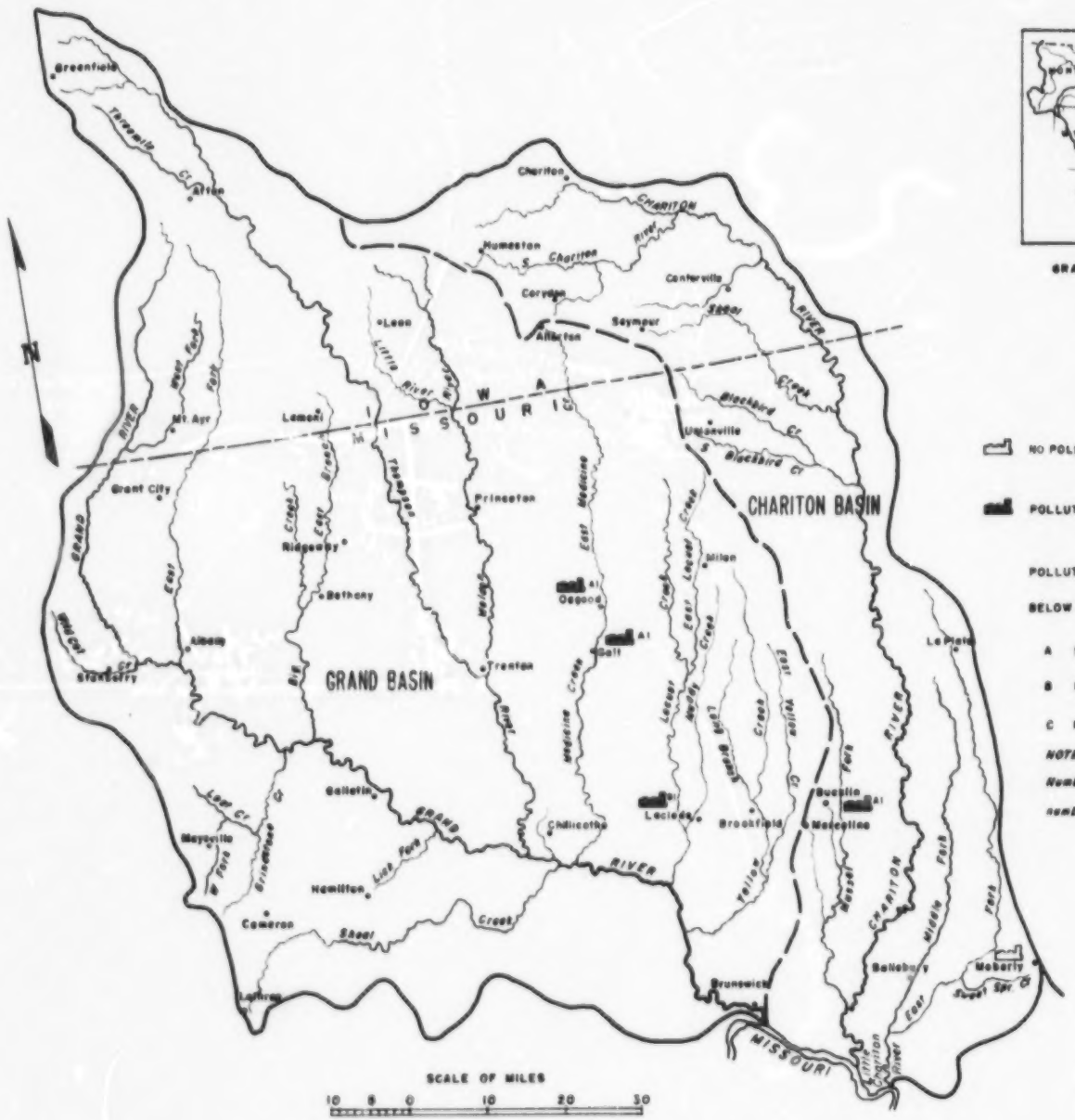
Numbers next to symbols or next to code letters represent number of treatment needs in the category designated

GRAND-CHARITON BASINS
MUNICIPAL
WASTE TREATMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 5

GRAND-CHARITON RIVER BASINS

LOCATION MAP



NO POLLUTION ABATEMENT NEEDS

POLLUTION ABATEMENT NEEDED

POLLUTION ABATEMENT NEEDS INDICATED BY LETTERS APPEARING BELOW 'POLLUTION ABATEMENT NEEDED' SYMBOLS AS FOLLOWS:

A NEW PLANT

B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT

C REPLACE EXISTING PLANT

NOTE-

Numbers next to symbols or next to code letters represent number of pollution abatement needs in the category designated

SCALE OF MILES

10 5 0 10 20 30

GRAND-CHARITON BASINS
INDUSTRIAL
POLLUTION ABATEMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 6

-313-

APPENDIX A

Table I. Grand-Chariton River Basins - Surface water supplies - Municipal

Municipalities	Source	Population served	Treatment[1]	Average consumption M.G.D.
Afton, Iowa	Imp. reservoir	750	DF	0.040
Allerton, Iowa	Imp. reservoir	670	ADF	-
Bethany, Mo.	Imp. reservoir	2,300	ADF	0.150
Brookfield, Mo.	Yellow Creek	5,000	ADF	0.300
Brunswick, Mo.	Grand River	1,150	DF	0.060
Bucklin, Mo.	Imp. reservoir	450	ADF	0.050
Cameron, Mo.	Imp. reservoir	2,400	ADF	0.125
Centerville, Iowa	Imp. reservoir	5,050	ADF	1.080
Chariton, Iowa	Imp. reservoir	4,900	ADF	0.400
Chillicothe, Mo.	Grand River	7,200	DFH	0.630
Corydon, Iowa	Imp. reservoir	1,150	DF	0.060
Grant City, Mo.	Imp. reservoir*	600	DF	0.030
Greenfield, Iowa	Imp. reservoir	1,400	ADF	0.077
Hamilton, Mo.	Imp. reservoir	700	DF	0.060
Humeston, Iowa	Imp. reservoir	-	ADF	-
Lamoni, Iowa	Imp. reservoir	1,050	DF	0.060
LaPlata, Mo.	Imp. reservoir	1,100	DF	0.040
Marceline, Mo.	Imp. reservoir	2,400	ADFH	0.650
Maysville, Mo.	Imp. reservoir	500	ADF	0.060
Milan, Mo.	Imp. reservoir	1,500	DF	0.150
Moberly, Mo.	Imp. reservoir	10,000	ADF	0.600
Mt. Ayr, Iowa	Imp. reservoir	1,800	ADF	0.075
Seymour, Iowa	Imp. reservoir	770	ADF	0.025
Trenton, Mo.	Thompson River	5,300	DF	1.000
Unionville, Mo.	Imp. reservoir	1,000	ADF	0.080
Totals		59,140		5.802

[1]Treatment - A - Aerated
D - Chlorinated
F - Coagulated, Settled, Filtered
H - Softened

*Grant City also uses a well water supply.

APPENDIX A

Table II. Grand-Chariton Basins - Municipal water supplies from ground sources

Municipality	State	Source[1]	Treatment[2]	Population served	Average consumption M. G. D.
Albany	Mo.	SW	D	1,700	0.150
Davis City	Iowa	DW, SW	N	470	0.070
Diagonal	Iowa	DW	AI	450	0.018
Gallatin	Mo.	DW	ADFHI	1,300	0.075
Keytesville	Mo.	SW	ADI	500	0.009
Lathrop	Mo.	SW	D	800	0.020
Leon	Iowa	DW	D	2,000	0.050
Princeton	Mo.	SW	ADFHI	1,000	0.125
Ridgeway	Mo.	DW	N	100	0.003
Salisbury	Mo.	SW	AFHI	1,200	0.054
Stanberry	Mo.	DW	N	1,300	0.075
Totals				10,820	0.649

[1]Source - DW - Deep Wells
SW - Shallow Wells

[2]Treatment - N - None
A - Aerated
D - Chlorinated
F - Coagulated, Settled, Filtered
H - Softened
I - Iron removal.

APPENDIX B

Table III. Grand-Chariton Basins - Length of streams and size of drainage areas

Stream	Length in river miles	Drainage area in square miles
Grand River	217	7,900
Yellow Creek	72	442
Locust Creek	83	640
Medicine Creek	78	-
Thompson River	151	-
Weldon River	-	-
Chariton River	280	2,960

Table IV. Grand Chariton Basins - Proposed flood control reservoirs*

Grand River Basin	Stream	Drainage area (sq.mi.)	Capacity (acre-feet) Flood control	Conservation and sediment	Total
Pattonsburg (Gallatin, Mo.)	Grand River	2,234	549,000	292,000	1,841,000
Trenton (Trenton, Mo.)	Thompson River	1,152	836,000	256,000	1,092,000
Mercer (Mercer, Mo.)	Weldon River	427	312,000	110,000	422,000
Meadville (Meadville, Mo.)	Parsons Creek	57	42,000	14,000	56,000
Linneus (Linneus, Mo.)	Locust Creek	572	427,000	63,000	490,000
Brookfield (Brookfield, Mo.)	Yellow Creek	140	108,000	17,000	125,000
Braymer (Braymer, Mo.)	Shoal Creek	390	271,000	44,000	315,000
Chariton River Basin					
Rathbun (Rathbun, Iowa)	Chariton River	558	327,000	156,000	483,000

*Reservoirs tentatively recommended by Corps of Engineers pending review.

APPENDIX B

Table V. Grand-Chariton Basins - Probable frequency of low mean monthly discharges

Years of record*	Stream and location	Miles to mouth Grand River	Miles to mouth Tributary	Drainage area square miles	Minimum monthly mean flows in cubic feet per second that may be expected once in: 2 yrs.	3 yrs.	5 yrs.	10 yrs.	Minimum flow of record c.f.s.
	SUMMER PERIOD (JUNE-SEPT)								
	Grand River								
16	Sumner, Mo.	39		6,880	367	324	224	59	41
16	Gallatin, Mo.	90		2,250	90	58	39	18	7
	Thompson River	64							
13	Trenton, Mo.		26	1,670	102	56	33	8	6
	Weldon River		28						
14	Mill Grove, Mo.		12	494	14	8	3	1	1
8	Mercer, Mo.		40	246	7	3	2	1	0.03
	Big Creek	108							
	East Fork		25						
11	Bethany, Mo.		1	95	0.40	0.1	0.05	0.02	0
	Medicine Creek	50							
15	Galt, Mo.		32	225	5	3	2	1	0.22
	Locust Creek	42							
14	Linneus, Mo.		21	550	13	6	1	0.4	0.0096
		Miles to mouth Chariton River	Tributary						
	Chariton River								
13	Keytesville, Mo.	39		1,950	74	40	30	12	8
12	Novinger, Mo.	140		1,370	26	19	7	2	1
8	Centerville, Iowa	196		727	13	10	6	4	4
	WINTER PERIOD (DEC-FEB)								
	Grand River								
16	Sumner, Mo.	39		6,880	450	282	153	128	32
16	Gallatin, Mo.	90		2,250	81	51	39	20	4
	Thompson River	64							
13	Trenton, Mo.		26	1,670	89	43	36	20	6
	Weldon River		28						
13	Mill Grove, Mo.		12	494	16	8	6	3	1
8	Mercer, Mo.		40	246	28	8	3	1	0.16
	Big Creek	108							
	East Fork		25						
10	Bethany, Mo.		1	95	3	1	0.1	0	0
	Medicine Creek	50							
16	Galt, Mo.		32	225	15	5	3	3	0.03
	Locust Creek	42							
14	Linneus, Mo.		21	550	49	11	5	3	0.0024
		Miles to mouth Chariton River	Tributary						
	Chariton River								
13	Keytesville, Mo.	39		1,950	209	66	43	28	14
13	Novinger, Mo.	140		1,370	119	32	16	12	4
8	Centerville, Iowa	196		727	104	28	6	3	2

*Hydrologic data was available from U.S.G.S. publications for the following years:
Grand River near Sumner, Mo. - 1925-1927, 1930, 1931, 1933, 1934, 1936, 1940-1947.
Grand River near Gallatin, Mo. - 1925-1927, 1930, 1931, 1933, 1934, 1936, 1940-1947.
Thompson River at Trenton, Mo. - 1930, 1931, 1933, 1934, 1936, 1940-1947.
Weldon River at Mill Grove, Mo. - Winter: 1930, 1931, 1933, 1934, 1936, 1940-1947 - Summer: 1929-1931, 1933, 1934, 1936, 1940-1947.
Weldon River near Mercer, Mo. - 1940-1947.
East Fork Big Creek near Bethany, Mo. - Winter: 1936, 1939-1947 - Summer: 1934, 1936, 1939-1947.
Medicine Creek near Galt, Mo. - Winter: 1925-1927, 1930, 1931, 1933, 1934, 1936, 1940-1947 - Summer: 1926, 1927, 1930, 1931, 1933, 1934, 1936, 1940-1947.
Locust Creek near Linneus, Mo. - 1930, 1931, 1933, 1934, 1936, 1939-1947.
Chariton River near Keytesville, Mo. - 1930, 1931, 1933, 1934, 1936, 1940-1947.
Chariton River near Novinger, Mo. - Winter: 1933, 1934, 1936, 1939-1947 - Summer: 1934, 1936, 1939-1947.
Chariton River near Centerville, Iowa - 1940-1947.

APPENDIX C

REVIEW OF IOWA WATER POLLUTION CONTROL LEGISLATION

I. General Statement

Iowa has a water pollution control act with principal authority vested in the State Department of Health. It is doubtful whether the act could be termed "comprehensive." The State Board of Health, the Iowa Natural Resources Council, and the State Geologist also have certain functions relating to control of water pollution. The act was last amended in 1951.

The Surgeon General has designated the State Department of Health as the State water pollution agency pursuant to the Federal Water Pollution Control Act.

Iowa statutes relating to water pollution are found in Code of 1950, sec. 84.1; Code of 1950, c. 135; Code of 1950, c. 136; Code of 1950, sec. 469.1 to 469.8; Code of 1950, c. 657 and sec. 732.3.

II. Administrative Organization

The State Department of Health is under the supervision of the Commissioner of Public Health, who is appointed for a four-year term by the Governor with the approval of two-thirds of the members of the Senate. The Commissioner is required to be a physician specially trained in public hygiene and sanitation. He is authorized to hire such assistants and employees as may be authorized by law and to assign them their duties. He is authorized to maintain certain named divisions in the Department, together with such others as may be necessary. Code of 1950, c. 135.

The State Board of Health acts in an advisory capacity to the State Department of Health on water pollution control and other matters. The Board consists of the Commissioner of Public Health, the members of the executive council, and five health officers appointed by the Governor. It meets semiannually on the second Tuesdays of January and July and at such special times as the Governor or Commissioner may designate. The Board elects its own president who serves for a term of one year. Members receive no compensation, but only traveling expenses. Code of 1950, c. 136. The executive council is composed of the Governor, Secretary of State, Auditor of State, Treasurer of State, and the Secretary of Agriculture. Code of 1950, sec. 19.1.

The Natural Resources Council is composed of seven members appointed by the Governor with the approval of two-thirds of the members of the Senate. Each member who is not a public employee receives $25. a day for time actually spent in discharging his duties. The executive officer is the Director, who is chosen by the Council. The Director, with the approval of the Council, is authorized to hire assistants and other employees. The duties of the Council pertain principally to flood control. Code of 1950, c. 455A.

The State Geologist, who is in charge of the Geological Survey, is appointed by the Geological Board which consists of the Governor, the Auditor of State, and the presidents of the Agricultural College, the State University, and the Iowa Academy of Science. Code of 1950, c. 305.

III. Powers and Duties

A. State Department of Public Health

1. Development of Comprehensive Program. There is no specific statutory authority granted the Department to develop a comprehensive program, to set standards of water purity, or to classify water. Such authority would seem to be implied, however, from the Department's powers (1) to exercise general supervision over the public health, promote public hygiene and sanitation (Code of 1950, sec. 135.11(1); (2) to investigate and prevent water pollution (Code of 1950, sec. 135.18 to 135.29; and (3) to make rules (Code of 1950, sec. 135.11 (17)). Also certain duties of the Natural Resources Council are delegated to it. See III B, infra.

2. Issuance of Permits and Review of Plans and Specifications. A new sewerage system may not be installed or an existing one extended or otherwise altered without a written permit from the Department. Before a permit will be issued, plans and specifications must be submitted. The installation or alterations must be in accordance with the submitted plans. These requirements are also applicable to extensions or additions to factories or other business enterprises which would substantially increase water pollution. The Department may require submission of plans and specifications of existing sewerage systems.

The Iowa Natural Resources Council may not issue a permit to build a dam if the use to which the water will be put will cause pollution. The Council may not issue a permit without a certificate of approval from the Department. No dam may be constructed without issuance of the proper permit. Code of 1950, sec. 469.1 to 469.9.

3. Enforcement. The Department may make investigations of water pollution on its own initiative or on the complaint of others. Code of 1950, sec. 135.18.

If the investigation reveals that pollution exists, a public hearing with notice to the alleged polluters is held. After the hearing the Department may order the guilty parties to discontinue the pollution. No order shall be issued without the written approval of a majority of the members of the Iowa Natural Resources Council. An appeal from the order lies to the district court where the trial is de novo, and without a jury. Code of 1950, sec. 135.19 to 135.23.

The orders of the Department are enforced by contempt proceedings. The penalty is a fine of not more than $1,000. Code of 1950, sec. 135.24 and 135.25.

The pollution of a river, stream, or pond is declared by law to be a public nuisance. The penalty is a fine of not more than $1,000, or a jail sentence of not more than one year. The court may also order the nuisance abated. Laws of 1950, c. 657.

The throwing of dead animals, night soil, or garbage into a stream, pond, well, or spring is a crime punishable by a maximum fine of $100, or by imprisonment for not more than 30 days. Code of 1950, sec. 732.3.

4. Conduct of Studies, Investigations and Research. The Department's express authority in this field is limited to surveys of particular streams or bodies of water with a view to eliminating particular sources of pollution. Code of 1950, sec. 135.18. For the duties of the Natural Resources Council in this respect, see IIIB, infra.

5. Cooperation with Other Public and Private Agencies. The Department is given no express authority to secure to the State the benefits of the Federal Water Pollution Control Act, but it is authorized to accept financial aid from the United States for the purpose of assisting in carrying on the State's public health work. Code of 1950, sec. 135.39. There is no express authority for the Department to enter into interstate agreements.

6. Administrative Powers. The Department has no express power to hold hearings except in connection with particular sources of pollution. See III A 3 above. It is given no express power to issue subpoenas, administer oaths, or to pay witnesses.

It has the general power to establish, publish, and enforce rules necessary for the discharge of its duties. Code of 1950, sec. 135.11(17). It has specific authority to adopt and enforce rules with reference to submission of plans and specifications of sewerage systems. Code of 1950, sec. 135.28.

B. Iowa Natural Resources Council.

The Council is directed by statute to make surveys and investigations of health problems and of stream pollution as they relate to flood control and water resources. The Council is also directed to formulate plans and recommendations for the protection and preservation of the water resources of the State. Code of 1950, sec. 455A.17 and 455A.18. Acts of 53d G.A., c. 203, par. 18. For other duties of the Council with reference to water pollution, see III A 2 and III A 3 above. In practice the Department of Health seems to discharge most of the Council's water pollution control duties.

C. State Geologist.

Where a well is drilled for oil or gas, proper precautions must be taken to prevent the pollution of all water within 300 feet of the surface. Within 60 days after the completion of the well a report must be filed with the State Geologist showing a complete record of the precautions taken. Code of 1950, sec. 84.1.

IV. Exemption from Operation of the Act.

None.

V. Preservation of Existing Rights and Remedies.

The penalty provided in Code of 1950, sec. 135.25, is in addition to any others provided by law including the public nuisance provisions. See III A 3, above.

VI. Statement of Policy, Severability Clause, etc.

The act contains no statement of policy or severability clause.

VII. Interstate Agencies.

The Department of Health participates in the following interstate groups:

1. The Upper Mississippi River Sanitary Board. The other participating States are Minnesota, Wisconsin, Illinois and Missouri. Among other things the Board has made malaria surveys and sponsored research in the field of sewerage treatment.

2. The Missouri Basin Public Health Council, which includes the States within the area of the Missouri Drainage Basin Office. The other States are Nebraska, Montana, North Dakota, South Dakota, Wyoming, Minnesota, Colorado, Kansas, and Missouri. A subdivision, the Lower Missouri Basin Health Council, includes Iowa, South Dakota, Nebraska, Kansas, and Missouri.

MISSOURI WATER POLLUTION CONTROL LEGISLATION

I. General Statement

Missouri has no comprehensive water pollution control act.[1/] The duty and responsibility of safeguarding the health of the people is vested in the Division of Health of the Department of Public Health and Welfare. Mo. R.S.A. § 9759.14. The Department of Public Health and Welfare (Division of Health) has been designated by the Surgeon General as the State Water Pollution Control Agency, inasmuch as no other State agency has comprehensive powers.

II. Administrative Organization

The chief administrative officer of the Division of Health is a director appointed by the Governor and must be confirmed by the Senate. The Division Director must be a physician in good standing, a citizen of Missouri, and a graduate of a reputable school of the healing arts, especially trained in sanitary science. Mo. R.S.A. §§ 9759.6 and 9759.16. The Director of the Department of Public Health and Welfare is appointed by the Governor, with Senate confirmation, and appointments of personnel and promulgations of orders and findings made by the Division must be approved by him.

III. Powers and Duties

1. Development of Comprehensive Programs. No statutory authority exists for the development of comprehensive programs.

2. Issuance of Permits and Review of Plans and Specifications. The Missouri statutes contain no specific statutory authority for the issuance of permits or the review of plans and specifications.

3. Enforcement. There is no specific statutory authority for enforcement. Rules and regulations or procedures made by the Division must be followed and obeyed or the person neglecting or refusing to do so shall be guilty of a misdemeanor. Mo. R.S.A. § 9750.

Any person who causes deleterious substances to be placed, run, or drained into any of the waters of Missouri in quantities sufficient to injure, stupefy, or kill fish which may inhabit such waters at or below the point where such substances enter the water shall be deemed guilty of a misdemeanor. This section also provides that it shall not be a violation for any person engaged in industry to cause or permit any waters subject to his control or used in such industry to be so discharged under such precautionary measures as have been specifically approved by the Conservation Commission. Mo. R.S.A. § 8971.19.

[1/] During the 1949 session of the Legislature a bill providing for comprehensive water pollution control was passed by the House, but was not acted upon by the Senate.

All rules and regulations authorized and made by the State agency supersede all local ordinances, rules, and regulations, must be observed throughout the State, and are enforced by all local and State health authorities. Mo. R.S.A. § 9748.

It is the duty of the county and city health officers to enforce the rules and regulations of the State Division of Health throughout their respective counties. Section 192.25 of S.B. 1051, approved January 6, 1950.

4. Conduct of Studies, Investigations, and Research. The Division of Health is authorized to make studies of the causes and prevention of diseases. Mo. R.S.A. § 9759.14.

The Director of the Department has the power to make inquiries and investigations. Mo. R.S.A. § 9759.5.

The Director of the Department may establish in his central office a bureau of research and statistics. Mo. R.S.A. § 9759.12. In addition the Division of Health is authorized to maintain such bureaus as may be necessary from time to time. Mo. R.S.A. § 9759.15.

5. Cooperation with Other Public and Private Agencies. None

6. Administrative Powers. No specific authority given by statute with respect to water pollution.

Section 192.20 of S.B. 1051, approved January 6, 1950, provides that the approval of new water supplies of new municipalities must necessarily involve consideration of sewage provisions for safety to public health.

The Director of the Department has the power to hold such hearings as may be necessary and has the authority to subpoena witnesses, administer oaths, and provide for the payment and expenses of witnesses. Mo. R.S.A. § 9759.5.

It is the general duty and responsibility of the Division of Health to safeguard the health of the people in the State and all its subdivisions. Mo. R.S.A. § 9759.14.

IV. Exemptions from Operation of Act.

None.

V. Preservation of Existing Rights and Remedies

None.

VI. Statement of Policy

None.

VII. Interstate Agencies

The Department of Health participates in the following interstate agencies:

1. The Upper Mississippi River Sanitary Board. The other participating States are Minnesota, Wisconsin, Illinois, and Iowa. Among other things the Board has made malaria surveys and sponsored research in the field of sewage treatment.

2. The Missouri Basin Health Council, which includes the States within the area of the Missouri Drainage Basin Office. The other States are Nebraska, Montana, North Dakota, South Dakota, Wyoming, Minnesota, Colorado, Kansas and Iowa.

3. The Public Health Service and the health departments of Iowa, Missouri, Kansas, South Dakota, and Nebraska have entered into a written agreement effective January 1, 1950, to make a survey of pollution of the Missouri River from Yankton, South Dakota, to the mouth.

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